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A

SYSTEM

OF

GEOMETRY AND TRIGONOMETRY:

TOGETHER WITH A

Treatise on Surveying;

TEACHING VARIOUS WAYS OF TAKING THE SURVEY
OF A FIELD; ALSO TO PROTRACT THE SAME
AND FIND THE AREA.

LIKEWISE,

Rectangular Surveying;

OR,

AN ACCURATE METHOD OF CALCULATING THE AREA OF
ANY FIELD ARITHMETICALLY, WITHOUT THE
NECESSITY OF PLOTTING IT.

To the whole are added several Mathematical Tables, necessary for solving Questions in Trigonometry and Surveying; with a particular explanation of those Tables, and the manner of using them.

SECOND EDITION.

COMPILED FROM VARIOUS AUTHORS,
BY ABEL FLINT, A. M.

HARTFORD:
PRINTED FOR OLIVER D. COOKE,
BY LINCOLN & GLEASON.
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1808.

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District of Connecticut, ss.

Be it remembered, *That on the thirtieth day of October in the twenty-ninth year of the Independence of the United States of America,* Oliver D. Cooke, *of the said District hath deposited in this Office the title of a Book the right whereof he claims as Proprietor in the words following, viz.*

"A System of Geometry and Trigonometry: together with a "Treatise on Surveying; teaching various ways of taking the Survey of a Field; also to protract the same and find the Area. Likewise Rectangular Surveying; or, an accurate method of calculating the Area of any Field arithmetically, without the necessity of "Plotting it. To the whole are added several mathematical Tables, "necessary for solving questions in Trigonometry and Surveying; "with a particular explanation of those Tables and the manner of "using them. Compiled from various Authors, by Abel Flint, *"A. M."*

In conformity to the Act of the Congress of the United States entitled, "An Act for the Encouragement of Learning by securing the "Copies of Maps, Charts and Books to the Authors and Proprietors "of such Copies during the times therein mentioned."

C. DENISON,
Clerk of the District of Connecticut.

Connecticut ss. District Clerk's Office,
A true Copy of Record,
Attest,
Ch. Denison, *Clerk.*

RECOMMENDATIONS.

HAVING perused, with some attention, the following Treatise on Surveying, in Manuscript, it appears to me to be estimable for its simplicity and perspicuity ; and, by excluding all matter but remotely connected with the main subject, and reducing the Tables of Logarithms, of Logairthmic Sines, Tangents and Secants, and of Difference of Latitude and Departure, without imparing their use, in their application to most cases which occur in common Surveying, and supplying any possible defect by a Table of Natural Sines, to comprise, in the limits of a pocket Volume, whatever is most essential and most useful in the Art, including the important modern improvement of RECTANGULAR SURVEYING ; *and on the whole, particularly from the size of the volume, to be well adapted to general use.*

JOHN TREADWELL.

FARMINGTON, *September 20th*, 1804.

WE the subscribers have carefully perused a Treatise on Surveying, prepared for the Press by the Rev. Abel Flint of Hartford; and find it worthy of the public patronage. Every thing not immediately necessary for the practical Surveyor has been excluded; while it comprises all which is requisite in Field Surveying, both on the old and new plan; elucidated and explained with a degree of conciseness and perspicuity not usually to be found in Treatises on the same subject. The Mathematical Tables are reduced to less than half the size occupied by others; and any inconvenience which might result from such reduction is obviated by the insertion of a Table of Natural Sines, not usually found in works of this nature. The Surveyor who shall own this will not be under the necessity of purchasing GIBSON *which is a more expensive work.*

ASHER MILLER, Surveyor General.
GEORGE GILLET, Deputy Surveyor
for TOLLAND County.

MIDDLETOWN, *October* 3*d*, 1804.

PREFACE.

THE following work is chiefly a compilation from other Books; and but very little new is added except a more full explanation, than has yet been published, of RECTANGULAR SURVEYING, or the method of calculating the Area of Fields arithmetically, without drawing a plot of them and measuring with a Scale and Dividers, as has been the common practice; and also a more particular explanation of the use of Natural Sines than is contained in most Mathematical Books.

The Compiler has endeavoured to render this work so easy and intelligible that a Learner will require but little assistance from an Instructor, except with regard to the construction and use of Mathematical and Surveying instruments. Before, however, he enters on the study of this Book he must be well acquainted with common Arithmetic, with Decimal Fractions and the Square Root; and he must also know the various characters or marks used in Arithmetic.

A Surveyor will doubtless find many questions arise in the course of his practice, for the solution of which no particular directions are here given; nor is it possible to give directions for every case that may occur. In all practical Sciences much must be left to the judgment of the practitioner, who, if he is well acquainted with the general principles of his Art, will readily learn to apply those principles to particular cases.

The primary design of this treatise is to teach common Field Surveying; at the same time it contains the

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[illegible] 1804.

elements of Surveying upon a larger scale; and the system of Geometry and Trigonometry with which it is introduced, with the Problems for the mensuration of Superficies, as also the Mathematical Tables at the end, will be found useful for many other purposes. It would be well, therefore, for those who do not intend to become practical Surveyors to acquaint themselves with what is here taught; and with this view the following work is very proper to be introduced into Academies, and those higher Schools which are designed to fit young men for active business in life. Indeed every person who frequently buys and sells land should learn to calculate the Contents of a Field arithmetically; a knowledge which may be acquired in a very little time, from the particular explanation here given of that method.

Nothwithstanding the many Books already published on the subjects here treated upon, it was thought a work of this kind was really wanted, and that if judiciously executed it would be useful. It is more particularly necessary at the present time in Connecticut, as the Legislature of the State have lately enacted a Law on the subject of Surveying, in consequence of which more attention must be paid to the Theory of that Art than has been common.

These considerations induced the Compiler to select from various publications what appeared to him important; and to arrange the whole in a method best adapted, in his view, for teaching that useful Art. How far he has succeeded in his endeavours to simplify the subject, and render it easy to the Learner, must be submitted to the test of experience.

RD, (Con.) October, 1804.

A General View of the Contents of this Work.

THE System of Geometry is divided into two parts. The first contains Geometrical Definitions respecting Lines, Angles, Superficies, &c. The second part contains a number of Geometrical Problems necessary for Trigonometry and Surveying.

The System of Trigonometry is also divided into two parts: and teaches the solution of Questions in Right and Oblique angled Trigonometry, by Logarithms and also by Natural Sines.

The Treatise on Surveying is divided into three parts. Part first treats of measuring Land, and is divided into three Sections. The first contains several Problems respecting Mensuration, and for finding the Area of various Right-lined Figures and Circles.

The second Section teaches different methods of taking the Survey of fields; also to protract them, and find their Area in the manner commonly practised, and likewise by Arithmetical and Trigonometrical calculations, without measuring Diagonals and Perpendiculars with a Scale and Dividers; interspersed with sundry useful rules and directions.

The third Section is a particular explanation and demonstration of *Rectangular Surveying*, or the method of computing the Area of Fields from the Field Notes, by Mathematical Tables, without the necessity of plotting the Field. To this Section is added a useful Problem for ascertaining the true Area of a Field which has been measured by a Chain too long or too short.

Part second treats of laying out Land in various shapes.

Part third contains sundry Problems and Rules for dividing Land and determining the true Course and Distance of dividing Lines, or from one part of a Field to another. To this is added an Appendix concerning the Variation of the Compass and Attraction of the Needle; also, a Rule to find the difference between the present Variation, and that at a time when a Tract was formerly surveyed, in order to trace or run out the original lines.

The Mathematical Tables, are A Traverse Table, or Table of Difference of Latitude and Departure, calculated for every Degree and quarter of a Degree, and for any distance up to 50; a Table of Natural Sines calculated for every Minute; a Table of Logarithms comprised in four pages, yet sufficiently extensive for common use; and a Table of Logarithmic or Artificial Sines, Tangents and Secants, calculated for every 5 Minutes of a Degree. To these Tables are prefixed particular explanations of the manner of using them.

GEOMETRY.

GEOMETRY is a Science which treats of the properties of Magnitude.

PART I.

Geometrical Definitions.

1. A Point is a small Dot; or, Mathematically considered, is that which has no parts, being of itself indivisible.

2. A Line has length but no breadth.

3. A Superficies or Surface, called also Area, has length and breadth, but no thickness.

4. A Solid has length, breadth and thickness.

5. A Right Line is the shortest that can be drawn between two Points.

6. The inclination of two Lines meeting one another, or the opening between them, is called an Angle. Thus at B. PLATE I. *Figure* 1. is an Angle, formed by the meeting of the Lines AB and BC.

7. If a Right Line CD. *Fig.* 2. fall upon another Right Line AB, so as to incline to neither side, but make the Angles on each side equal, then those Angles are called Right Angles; and the Line CD is said to be Perpendicular to the other Line.

8. An Obtuse Angle is greater than a Right Angle; as ADE. *Fig.* 3.

9. An Acute Angle is less than a Right Angle; as EDB. *Fig.* 3.

Note. When three letters are used to express an Angle, the middle letter denotes the angular Point.

10. A Circle is a round Figure, bounded by a Line equally distant from some Point, which is called the Centre. *Fig.* 4.

11. The Circumference or Periphery of a Circle is the bounding Line; as ADEB. *Fig.* 4.

12. The Radius of a Circle is a Line drawn from the Centre to the Circumference; as CB. *Fig.* 4. Therefore all Radii of the same Circle are equal.

13. The Diameter of a Circle is a Right Line drawn from one side of the Circumference to the other, passing through the Centre; and it divides the Circle into two equal parts, called Semicircles; as AB or DE. *Fig.* 5.

14. The Circumference of every Circle is supposed to be divided into 360 equal parts called Degrees; and each Degree into 60 equal parts, called Minutes; and each Minute into 60 equal parts, called Seconds; and these into Thirds, &c.

Note. Since all Circles are divided into the same number of Degrees, a Degree is not to be accounted a quantity of any determinate length, as so many inches or Feet, &c. but is always to be reckoned as being the 360th part of the Circumference of any Circle, without regarding the bigness of the Circle.

15. An Arch or Arc of a Circle is any part of the Circumference; as BF or FD, *Fig.* 5; and is said to be an Arch of so many Degrees as it contains parts of 360 into which the whole Circle is divided.

16. A Chord is a Right Line drawn from one end of an Arch to the other, and is the measure of the Arch; as HG is the Chord of the Arch HIG. *Fig.* 6.

Note. The Chord of an Arch of 60 degrees is equal in length to the Radius of the Circle of which the Arch is a part.

17. The Segment of a Circle is a part of a Circle, cut off by a Chord; thus the space comprehended between the Arch HIG and the Chord HG is called a Segment. *Fig*. 6.

18. A Quadrant is one quarter of a Circle; as ACB. *Fig*. 6.

19. A Sector of a Circle is a space contained between two Radii and an Arch less than a Semicircle; as BCD or ACD. *Fig*. 6.

20. The Sine of an Arch is a Line drawn from one end of the Arch, perpendicular to the Radius or Diameter drawn through the other end: Or, it is half the Chord of double the Arch; thus HL is the Sine of the Arch HB. *Fig*. 7.

21. The Sines on the same Diameter increase in length till they come to the Centre, and so become the Radius. Hence it is plain that the Radius CD *Fig*. 7. is the greatest possible Sine, or Sine of 90 Degrees.

22. The Versed Sine of an Arch is that part of the Diameter or Radius which is between the Sine and the Circumference; thus LB is the Versed Sine of the Arch HB. *Fig* 7.

23. The Tangent of an Arch is a Right Line touching the Circumference, and drawn perpendicular to the Diameter; and is terminated by a Line drawn from the Centre through the other end of the Arch; thus BK is the Tangent of the Arch BH. *Fig*. 7.

Note. The Tangent of an Arch of 45 Degrees is equal in length to the Radius of the Circle of which the Arch is a part.

24. The Secant of an Arch is a Line drawn from the Centre through one end of the Arch till it meets the Tangent; thus CK is the Secant of the Arch BH. *Fig*. 7.

25. The Complement of an Arch is what the Arch wants of 90 Degrees, or a Quadrant; thus HD is the Complement of the Arch BH. *Fig*. 7.

26. The Supplement of an Arch is what the Arch wants of 180 Degrees, or a Semicircle; thus ADH is the Supplement of the Arch BH. *Fig*. 7.

27. The Sine, Tangent or Secant of the Complement of any Arch is called the Co-Sine, Co-Tangent or Co-Secant of the Arch; thus FH is the Sine, DI the Tangent and CI the Secant of the Arch DH; or they are the Co-Sine, Co-Tangent and Co-Secant of the Arch BH. *Fig.* 7.

28. The measure of an Angle is the Arch of a Circle contained between the two Lines which form the Angle, the angular Point being the Centre; thus the Angle HCB. *Fig.* 7. is measured by the Arch BH; and is said to contain so many Degrees as the Arch does.

Note. An Angle is esteemed greater or less according to the opening of the Lines which form it, or as the Arch intercepted by those Lines contains more or fewer Degrees. Hence it may be observed, that the bigness of an Angle does not depend at all upon the length of the including Lines; for all Arches described on the same Point, and intercepted by the same Right Lines, contain exactly the same number of Degrees, whether the Radius be longer or shorter.

29. The Sine, Tangent or Secant of an Arch is also the Sine, Tangent or Secant of the Angle whose measure the Arch is.

30. Parallel Lines are such as are equally distant from each other; as AB and CD. *Fig.* 8.

31. A Triangle is a Figure bounded by three Lines; as ABC. *Fig.* 9.

32. An Equilateral Triangle has its three sides equal in length to each other. *Fig.* 9.

33. An Isoceles Triangle has two of its sides equal, and the other longer or shorter. *Fig.* 10.

34. A Scalene Triangle has three unequal Sides. *Fig.* 11.

35 A Right Angled Triangle has one Right Angle. *Fig.* 12.

36. An Obtuse Angled Triangle has one Obtuse Angle. *Fig.* 13

37. An Acute Angled Triangle has all its Angles Acute. *Fig.* 9, or 10.

38. Acute and Obtuse Angled Triangles are called Oblique Angled Triangles, or simply Oblique Triangles; in all which the bottom Side is generally called the Base and the other two, Legs.

39. In a Right Angled Triangle the longest Side is called the Hypothenuse, and the other two, Legs, or Base and Perpendicular.

Note. The three Angles of every Triangle being added together will amount to 180 Degrees; consequently the two Acute Angles of a Right Angled Triangle amount to 90 Degrees, the Right Angle being also 90.

40. The perpendicular height of a Triangle is a Line drawn from one of the Angles to its opposite Side; thus the dotted Line AD. *Fig.* 14. is the perpendicular height of the Triangle ABC.

Note. This Perpendicular may be drawn from either of the Angles; and whether it falls within the Triangle, or on one of the Lines continued beyond the Triangle, is immaterial.

41. A Square is a Figure bounded by four equal Sides, and containing four Right Angles. *Fig.* 15.

42. A Parallelogram, or Oblong Square, is a Figure bounded by four Sides, the opposite ones being equal and the Angles Right. *Fig.* 16.

43. A Rhombus is a Figure bounded by four equal Sides, but has its Angles Oblique. *Fig.* 17.

44. A Rhomboides is a Figure bounded by four Sides, the opposite ones being equal, but the Angles Oblique. *Fig.* 18.

45. The perpendicular height of a Rhombus or Rhomboides is a Line drawn from one of the Angles to its opposite Side; thus the dotted Lines A B. *Fig.* 17. and *Fig.* 18. represent the perpendicular height of the Rhombus and Rhomboides.

46. A Trapezoid is a Figure bounded by four Sides, two of which are parallel though of unequal lengths. *Fig.* 19. and *Fig.* 20.

Note. Fig. 19. is sometimes called a Right Angled Trapezium.

47. A Trapezium is a Figure bounded by four unequal Sides. *Fig.* 21.

48. A Diagonal is a Line drawn between two opposite Angles; as the Line AB. *Fig.* 21.

49. Figures which consist of more than four Sides are called Polygons; if the Sides are equal to each other they are called regular Polygons, and are sometimes named from the number of their Sides, as Pentagon or Hexagon, a Figure of five or six Sides, &c; if the Sides are unequal they are called irregular Polygons.

PART II.

Geometrical Problems.

PROBLEM I. *To draw a Line parallel to another Line at any given distance; as at the Point D, to make a Line, parallel to the Line AB.* PLATE 1. *Fig* .22.

With the Dividers take the nearest distance between the Point D and the given Line AB; with that distance set one foot of the Dividers any where on the Line AB, as at E, and draw the Arch C; through the Point D draw a Line so as just to touch the top of the Arch C.

A more convenient way to draw parallel Lines is with a parallel Rule.

PROBLEM II. *To bisect a given Line; or to find the middle of it. Fig.* 23.

Open the Dividers to any convenient distance, more than half the given Line AB, and with one foot in A describe an Arch above and below the Line, as at C and D; with the same distance, and one foot in B describe Arches to cross the former; lay a Rule from C to D, and where the Rule croses the Line, as at E, will be the middle.

PROBLEM III. *To erect a Perpendicular from the end, or any part of a given Line. Fig.* 24.

Open the Dividers to any convenient distance, as from D to A, and with one foot on the Point D, from which the Perpendicular is to be erected, describe an Arch, as AEG; set off the same distance from A to E and from E to G; upon E and G describe two Arches to intersect each other at H; draw a Line from H to D, and one Line will be perpendicular to the other.

Note. There are other methods of erecting a Perpendicular, but this is the most simple.

PROBLEM IV. *From a given Point, as at C, to drop a Perpendicular on a given Line AB. Fig.* 25.

With one foot of the Dividers in C describe an Arch to cut the given Line in two places, as at F and G; upon F and G describe two Arches to intersect each other below the Line as at D; lay a Rule from C to D and draw a Line from C to the given Line.

Perpendiculars may be more readily raised and let fall, by a small Square made of Brass, Ivory or Wood.

PROBLEM V. *To make an Angle at E, equal to a given Angle ABC. Fig.* 26.

Open the Dividers to any convenient distance, and with one foot in B describe the Arch FG; with the same distance and one foot in E, describe an Arch from H; measure the Arch FG, and lay off the same distance on the Arch from H to I; draw a Line through I to E, and the Angles will be equal.

PROBLEM VI. *To make an Acute Angle equal to a given number of Degrees, suppose* 36. *Fig.* 27.

Draw the Line AB to any convenient length; from a Scale of Chords take 60 Degrees with the Dividers, and with one foot in B describe an Arch from the Line AB; from the same Scale take the given number of Degrees, 36, and lay it on the Arch from C to D; draw a Line from B through D, and the Angle at B will be an Angle of 36 Degrees.

Suppose the side BC 98; the Angle at B 45° 15′, the Angle at D 108° 30′, consequently the other Angle 26° 15′.

Draw the side BC in length 98; on the Point B make an Angle of 45° 15′; on the Point C make an Angle of 26° 15′, and draw the Lines BD and CD.

PROBLEM XIV. *To make an Oblique Angled Triangle, two Sides and an Angle opposite to one of them being given. Fig.* 35.

Suppose the Side BC 160, the Side BD 79, and the Angle at C 29° 9′.

Draw the Side BC in length 160; at C make an Angle of 29° 9′, and draw an indefinite Line through where the Degrees cut the Arch; take 79 in the Dividers, and with one foot in B lay the other on the Line CD; the point D will be the other Angle of the Triangle.

PROBLEM XV. *To make an Oblique Angled Triangle, two Sides and their contained Angle being given. Fig.* 36.

Suppose the Side BC 109, the Side BD 76, and the Angle at B 101° 30′.

Draw the Side BC in length 109; at B make an Angle of 101° 30′, and draw the Side BD in length 76; draw a Line from D to C and it is done.

PROBLEM XVI. *To make a Square.* PLATE II. *Fig.* 37.

Draw the Line AB the length of the proposed Square; from B erect a Perpendicular to C and make it of the same length as AB; from A and C, with the same distance in the Dividers, describe Arches intersecting each other at D, and draw the Lines AD and DC.

PROBLEM XVII. *To make a Parallelogram. Fig.* 38.

Draw the Line AB equal to the longest Side of the Parallelogram; on B erect a Perpendicular the length of the shortest side to C; from C, with the longest Side, and from A, with the shortest Side, describe Arches intersecting each other at D, and draw the Lines AD and CD.

PROBLEM XVIII. *To describe a Circle which shall pass through any three given Points, not lying in a Right Line, as A, B, D. Fig. [illegible]*

Draw Lines from A to B and from B to D; bisect those Lines by Problem II. and the Point where the bisecting Lines intersect each other, as at C, will be the Centre of the Circle.

PROBLEM XIX. *To find the centre of a Circle.*

By the last Problem it is plain, that if three Points be any where taken in the given Circle's Periphery, the Centre of the Circle may be found as there taught.

Directions for constructing irregular Figures of four or more sides may be found in the following Treatise on Surveying.

first Term, the Remainder will be the Log. of the fourth Term, which seek in the Tables and find its corresponding Number or Degrees and Minutes.

See the Introduction to the Table of Logarithms; which should be attentively studied by the Learner before he proceeds any further.

Note. The Logarithm for Radius is always 10, which is the Logarithmic Sine of 90°, and the Logarithmic Tangent of 45°.

The preceding PROPOSITIONS and RULES being duly attended to, the solution of the following CASES of *Rectangular Trigonometry* will be easy.

CASE I.

The Angles and Hypothenuse given to find the Legs. Fig. 39.

In the Triangle ABC, given the Hypothenuse AC 25 Rods or Chains; the Angle at A 35° 30′, and consequently the Angle at C 54° 30′: to find the Legs.

Making the Hypothenuse Radius, the Proportions will be;

To find the Leg AB.		*To find the Leg* BC.	
As Radius - -	10.00000	As Radius - - -	10.00000
: Hyp. AC, 25 -	1.39794	: Hyp. AC, 25 - -	1.39794
: : Sine ACB, 54° 30′	9.91069	: : Sine CAB, 35° 30′	9.76395
	11.30863		11.16189
	10.00000		10.00000
: Leg AB, 20.35 -	1.30863	: Leg BC, 14. 52 -	1.16189

Note When the first Term is Radius, it may be Subtracted by cancelling the first figure of the Sum of the other two Terms.

Making the Leg AB Radius, the Proportions will be:

To find the Leg AB.	*To find the Leg* BC.
As Secant CAB, 35° 30′	As Secant CAB, 35°30′
: Hyp. AC, 25	: Hyp. AC, 25
: : Radius	: : Tangent CAB,35° 30′
: Leg AB, 20. 35	: Leg BC, 14. 52

Making the Leg BC Radius, the Proportions will be:

To find the Leg AB.	*To find the Leg* BC.
As Secant ABC, 54° 30′	As Secant ACB, 54° 30′
: Hyp. AC, 25	: Hyp. AC, 25
: : Tangent ACB, 54° 30′	: : Radius
: Leg AB, 20.35	: Leg. BC, 14.52

The Logarithms of the four last Proportions being looked out, and added and subtracted according to the Rule, the result will be found to be the same as the two first Proportions.

By Natural Sines.

This CASE may be solved by Natural Sines,* according to the following Proportions:

As Unity or 1; Is to the length of the Hypothenuse; So is the Natural Sine of the smallest Angle; To the length of the shortest Leg. Or, So is the Natural Sine of the largest Angle; To the length of the longest Leg.

Or, which is the same thing, Multiply the Natural Sines of the two Angles by the Hypothenuse, the Products will be the length of the two Legs.

EXAMPLE.

Nat. Sine of 35° 30′	Nat. Sine of 54° 30′
0.58070	0.81412
Hyp. 25	Hyp. 25
290350	407060
116140	162824
14.51750	20.35300
Leg BC 14.52	Leg AB 20.35

---

* See the Introduction to the Table of Natural Sines.

Note. The third Decimal figure in the first Product being 7, the preceding figure may be called one more than it is, *viz.* 2. And whenever in any Product, &c. there are more places of Decimals than you wish to work with, if the one at the Right Hand of the last which you wish to retain is more than 5, add a Unit to the last; because a greater number than 5 is more than half.

As the Table of Artificial or Logarithmic Sines, Tangents and Secants, contained in this Book, is calculated only for every 5 Minutes of a Degree, whenever any Question is to be solved where the Minutes cannot be found in that Table; or where the length of the Hypothenuse is such a number as cannot be found in the Table of Logarithms for Numbers, the Question may be solved by Natural Sines, as above taught.

CASE II.

The Angles and one Leg given, to find the Hypothenuse and the other Leg. Fig. 40.

In the Triangle ABC, given the Leg AB 325, the Angle at A 33° 15′, and the Angle at C 56° 45′; to find the Hypothenuse and the Leg BC.

Making the given Leg Radius, the Proportions will be;

To find the Hypothenuse.		*To find the Leg BC.*	
As Radius,	10.00000	As Radius,	10.00000
: Leg AB, 325	2.51188	: Leg AB, 325	2.51188
: : Sec. CAB, 33° 15′	10.07765	: : Tan CAB, 33° 15′	9.81666
: Hyp. 388.6	12.58953	: Leg BC, 213.1	12.32854

Note. Reject the first figure, which is the same as subtracting Radius, and seek the numbers corresponding to the other figures.

Making the Leg BC Radius, the Proportions will be;

To find the Hypothenuse	*To find the Leg BC.*
As Tang. ACB, 56° 45′	As Tang. ACB, 56° 45′
: Leg AB, 325	: Leg AB, 325
: : Sec. ACB, 56° 45′	: : Radius
: Hyp. 388.6	: Leg BC, 213.1

Making the Hypothenuse Radius, the Proportions will be :

To find the Hypothenuse.	*To find the Leg BC.*
As Sine BCA, 56° 45′	As Sine BCA, 56° 45′
: Leg AB, 325	: Leg AB, 325
: : Radius	: : Sine BAC, 33° 15′
: Hyp. 388.6	: Leg BC, 213.1

Note. If the Leg BC had been given, instead of the Leg AB, the Proportions would have been the same *mutatis mutandis.*

By Natural Sines.

To solve this CASE by Natural Sines, institute the following Proportions :

To find the Hypothenuse. As the Natural Sine of the Angle opposite the given Leg ; Is to the length of the Leg ; So is Unity or 1 ; To the length of the Hypothenuse.

Or, which is the same thing, Divide the given Leg by the Natural Sine of its opposite Angle, and the Quotient will be the Hypothenuse.

To find the other Leg. As the Natural Sine of the Angle opposite the given Leg ; Is to the length of the given Leg ; So is the Natural Sine of the Angle opposite the other Leg ; To the length of the other Leg.

EXAMPLE.

Given Leg 325. Nat. Sine of 56° 45′, the Angle opposite the given Leg 0.83629. Nat. Sine of 33° 15′, the Angle opposite the other Leg 0.54829.

As 0.83629 : 325 : : 1 : 388.6

As 0.83629 : 325 : : 0.54829 : 213.07

CASE III.

The Hypothenuse and one Leg given, to find the Angles and the other Leg. Fig. 41.

In the Triangle ABC, given the Hypothenuse AC 50 and the Leg AB 40; to find the Angles and Leg BC.

Making the Hypothenuse Radius, the Proportion to find the Angle ACB will be:

As Hyp. 50 - -	1.69897
: Radius - -	10.00000
: : Leg AB, 40 -	1.60206
	11.60206
	1.69897
: Sine ACB, 53° 10′	9.90309

The Angle ACB being 53° 10′ the other is consequently 36° 50′.

Making the Leg AB Radius, the Angle BAC may be found by the following Proportion:

As Leg AB, 40 -	1.60206
: Radius - -	10.00000
: : Hyp. 50 - -	1.69897
	11.69897
	1.60206
: Sec. BAC, 36° 50′	10.09691

The Angles being found, the Leg BC may be found by either of the preceding CASES. It is 30.

* * *

By Natural Sines.

The Angle opposite the given Leg may be found by the following Proportion:

As the Hypothenuse; Is to Unity or 1; So is the given leg; To the Nat. Sine of its opposite Angle.

Or, which is the same thing, Divide the given Leg by the Hypothenuse, and the Quotient will be the Nat. Sine.

EXAMPLE.

The Leg AB 40 divided by the Hypothenuse 50 quotes 0.80000, which sought in the Table of the Sines, the nearest corresponding number of Degrees and Minutes will be found to be 53° 8' for the Angle ACB.

Note. The reason why the Angle as found by the Sines differs 2 Minutes from the Angle as found by Logarithms, is that the Table of Logarithmic Sines, &c. contained in this Book, is calculated only for every 2 Minutes. By a Table of Logarithmic Sines, &c. calculated for every Minute, the Angle will be found the same.

By the Square Root.

In this CASE the required Leg may be found by the Square Root, without finding the Angles, according to the following PROPOSITION:

In every Right Angled Triangle, the Square of the Hypothenuse is equal to the Sum of the Squares of the two Legs. Hence,

The Square of the given Leg being subtracted from the Square of the Hypothenuse, the Remainder will be the Square of the required Leg.

As in the preceding EXAMPLE: The Square of the Leg AB 40 is 1600; this subtracted from the Square of the Hypothenuse 50 which is 2500, leaves 900, the Square of the Leg BC, the Square Root of which is 30, the length of Leg BC as found by Logarithms.

CASE IV.

The Legs given to find the Angles and Hypothenuse. Fig. 42.

In the Triangle ABC, given the Leg AB 78.7 and the Leg BC 89; to find the Angles and Hypothenuse.

Making the Leg AB Radius, the Proportion to find the Angle BAC will be :

As Leg AB, 78.7 -	1.89597
: Radius - -	10.00000
: : Leg BC, 89 -	1.94939
	11.94939
	1.89597
: Tang. BAC, 48° 30′	10.05342

The Angle ACB is consequently 41° 30′.

Making the Leg BC Radius, the Proportion to find the Angle BCA will be the same as the above, *mutatis mutandis.*

The Angles being found, the Hypothenuse may be found by Case II. It is nearest 119.

By the Square Root.

In this Case the Hypothenuse may be found by the Square Root, without finding the Angles ; according to the following Proposition.

In every Right Angled Triangle, the Sum of the Squares of the two Legs is equal to the Square of the Hypothenuse.

In the above Example, the Square of AB 78.7 is 6193.69, the Square of BC 89 is 7921 ; these added make 14114.69 the Square Root of which is nearest 119.

By Natural Sines.

The Hypothenuse being found by the Square Root, the Angles may be found by Nat. Sines, according to the preceding Case.

```
Hyp.  Leg. BC.  Nat. Sine
119) 89. 00000 (74789
      83 3....
      ----
       570
       476
      ----
        940
        833
       ----
        1070
         952
        ----
         1180
         1071
         ----
          109
          ----
```

The nearest Degrees and Minutes corresponding to the above Nat. Sine are 48° 24′, for the Angle BAC. The difference between this and the Angle as found by Logarithms is occasioned by dividing by 119, which is not the exact length of the Hypothenuse, it being a Fraction too much.

PART II

OBLIQUE TRIGONOMETRY.

The solution of the two first CASES of *Oblique Trigonometry* depends on the following PROPOSITION.

In all Plane Triangles, the Sides are in proportion to each other as the Sines of their opposite Angles. That is, As the Sine of one Angle; Is to its opposite Side; So is the Sine of another Angle; To its opposite Side. Or, As one Side; Is to the Sine of its opposite Angle; So is another Side; To the Sine of its opposite Angle.

Note. When an Angle exceeds 90° make use of its Supplement, which is what it wants of 180°. As the Sine of 90° is the greatest possible Sine, the Sine of any greater number of Degrees will be as much less as that number of Degrees exceeds 90; and will be the same as the Sine of the Supplement of that number of Degrees: Thus the Sine of 100° is the same as the Sine of 80°, and the Sine of 130° the same as the Sine of 50°, &c

CASE I.

The Angles and one side given, to find the other Side Plate II. *Figure* 47.

In the Triangle ABC, given the Angle at B 48°, the Angle at C 72°, consequently the Angle at A 60°, and the Side AB 200; to find the Sides AC and BC.

To find the Side AC.		*To find the Side* BC.	
As Sine ACB, 72° -	9.97821	As Sine ACB, 72° -	9.97821
: Side AB, 200 - -	2.30103	: Side AB, 200 - -	2.30103
: : Sine ABC, 48° -	9.87107	: : Sine BAC, 60° -	9.93753
	12.17210		12.23856
	9.97821		9.97821
: Side AC, 156 - -	2.19389	: Side BC, 182 -	2.26035

By Natural Sines.

As the Nat. Sine of the Angle opposite the given Side; Is to the given Side; So is the Nat. Sine of the Angle opposite either of the required Sides; To that required Side.

Given Side 200; Nat. Sine of 72°, its opposite Angle, 0.95115; Nat. Sine of ABC 48°, 0.74334; Nat. Sine of BAC 60°, 0.86617.

As 0.95115 : 200 : : 0.74334 : 156
As 0.95115 : 200 : : 0.86617 : 182

CASE II.

Two Sides and an Angle opposite to one of them given, to find the other Angles and Side. Fig. 48.

In the Triangle ABC, given the Side AB 240, the Side BC 200, and the Angle at A 46° 30′; to find the other Angles and the Side AC.

To find the Angle ACB.

As Side BC, 200 -	2.30103
: Sine BAC, 46° 30′ -	9.86056
: : Side AB, 240 -	2.38021
	12.24077
	2.30103
: Sine ACB, 60° 30′	9.93974

Angle at A -	46° 30′
C -	60 30
	107.00
Sum of the three Angles	180°
Sum of two - -	107
Angle at B - -	73

The Side AC will be found by CASE I. to be nearest 253.

Note. If the given Angle be Obtuse the Angle sought will be Acute; but if the given Angle be Acute, and opposite a given lesser Side, then the Angle found by the operation may be either Obtuse or Acute. It ought therefore to be mentioned which it is, by the conditions of the question.

* * *

By Natural Sines.

As the Side opposite the given Angle; Is to the Nat. Sine of that Angle; So is the other given Side; To the Nat. Sine of its opposite Angle.

One given Side 200; Nat Sine of 46° 30′, its opposite Angle, 0.72537; the other given Side 240.

As 200 : 0.72537 : : 240 : 0.87044=60° 30′.

CASE III.

Two Sides and their contained Angle given, to find the other Angles and Side. Fig. 49.

The solution of this CASE depends on the following PROPOSITION.

In every Plane Triangle, As the Sum of any two Sides; Is to their Difference; So is the Tangent of half the Sum of the two opposite Angles; To the Tangent of half the Difference between them. Add this half difference to half the Sum of the Angles and you will have the greater Angle; and subtract the half Difference from the half Sum and you will have the lesser Angle

In the Triangle ABC, given the Side AB 240, the Side AC 180, and the Angle at A 36° 40′ to find the other Angles and Side.

Side AB	240	AB -	240
AC - -	180	AC -	180
Sum of the two Sides	420	Difference -	60

The given Angle BAC 36° 40′, subtracted from 180°, leaves 143° 20′ the Sum of the other two Angles; the half of which is 71° 40′.

As the Sum of two Sides, 420	2.62325
: Their Difference, 60 - -	1.77815
: : Tangent half unknown Ang. 71° 40′	10.47969
	12.25784
	2.62325
: Tangent half Difference, 23° 20′ -	9.63459
The half sum of the two unknown Angles,	71°40′
The half difference between them, -	23 20
Add, gives the greater Angle ACB -	95 00
Subtract, gives the lesser Angle ABC -	48 20

The Side BC may be found by Case I or II.

CASE IV.

The three Sides given to find the Angles. Fig. 50.

The solution of this Case depends on the following Proposition.

In every Plane Triangle, As the longest side; Is to the Sum of the other two Sides; So is the Difference between those two Sides; To the Difference between the Segments of the longest Side, made by a Perpendicular let fall from the Angle opposite that Side.

Half the Difference between these Segments, added half the Sum of the Segments, that is to half the length of the longest Side, will give the greatest Segment; and this half Difference subtracted from the half Sum will be the lesser Segment. The Triangle beingth us divided becomes two Right Angled Triangles, in which the Hypothenuse and one Leg are given to find the Angles.

In the Triangle ABC, given the Side AB 105, the Side AC 85, and the Side BC 50; to find the Angles.

Side AC -	85	AC - -	85
BC -	50	BC - -	50
Sum of the two Sides	135	Difference	35

As the longest Side AB, 105 -	2.02119
: Sum of the other two Sides, 135 -	2.13033
: : Difference between those Sides, 35	1.54407
	3.67440
	2.02119
: Difference between the Segments, 45	1.65321

Half the Side AB - - - -	52.5
Half the Difference of the Segments	22.5
Add, gives the greater Segment AD	75.0
Subtract, gives the lesser Segment BD	30.0

Thus the Triangle is divided into two Right Angled Triangles, ADC and BDC; in each of which the Hypothenuse and one Leg are given to find the Angles.

To find the Angle DCA		*To find the Angle* DCB.	
As Hyp. AC, 85 -	1.92942	As Hyp. BC, 50 -	1.69897
: Radius - -	10.00000	: Radius - -	10.00000
: : Seg. AD, 75 -	1.87506	: : Seg. BD, 30 -	1.47712
	11.87506		11.47712
	1.92942		1.69897
: Sine DCA, 61° 55′	9.94564	: Sine DCB, 36° 50′	9.77815

The Angle DCA 61° 55′ subtracted from 90° leaves the Angle CAD 28° 5′.

The Angle DCB 36° 50′ subtracted from 90′ leaves the Angle CBD 53° 10′.

The Angle DCA 61° 55′ added to the Angle DCB 36° 50′ gives the Angle ACB 98° 45′.

This Case may also be solved according to the following Proposition.

In every plane Triangle, As the Product of any two Sides containing a required Angle; Is to the Product of half the Sum of the three Sides, and the Difference between that half Sum and the Side opposite the Angle required; So is the Square of Radius; To the Square of the Co-Sine of half the Angle required.

Those who make themselves well acquainted with Trigonometry will find its application easy to many useful purposes, particularly to the mensuration of Heights and Distances; called Altimetry and Longimetry. These are here omitted because, as this work is designed principally to teach the Art of common Field Surveying, it was thought improper to swell its size, and consequently increase its price, by inserting any thing not particularly connected with that Art.

It is recommended to those who design to be Surveyors to study Trigonometry thoroughly; for though a common Field may be measured without an acquaintance with that Science, yet many cases will occur in practice where a knowledge of it will be found very beneficial; particularly in dividing Land, and ascertaining the boundaries of old Surveys. Indeed no one who is ignorant of Trigonometry, can be an accomplished Surveyor.

SURVEYING.

SURVEYING is the Art of measuring, laying out and dividing Land.

PART I.

MEASURING LAND.

The most common measure for Land is the Acre; which contains 160 Square Rods, Poles or Perches; or 4 Square Roods, each containing 40 Square Rods.

The instrument most in use, for measuring the Sides of Fields, is GUNTER'S Chain, which is in length 4 Rods or 66 Feet; and is divided into 100 equal parts, called Links, each containing 7 Inches and 92 Hundredths. Consequently, 1 Square Chain contains 16 Square Rods, and 10 Square Chains make 1 Acre.

In small Fields, or where the Land is uneven, as is the case with a great part of the Land in New-England, it is better to use a Chain of only two Rods in length; as the Survey can be more accurately taken.

SECTION I.

Preliminary Problems.

PROBLEM I. *To reduce Two Rod Chains to Four Rod Chains.*

Rule. If the number of Two Rod Chains be even take half the number for Four Rod Chains, and annex the Links if any: Thus, 16 Two Rod Chains and 37 Links make 8 Four Rod Chains and 37 Links.

But if the number of Chains be odd, take half the greatest even number for Chains, and for the remaining number add 50 to the Links: Thus, 17 Two Rod Chains and 42 Links make 8 Four Rod Chains and 92 Links.

PROBLEM II. *To reduce Two Rod Chains to Rods and Decimal Parts.*

Rule. Multiply the Chains by 2 and the Links by 4, which will give Hundredths of a Rod: Thus, 17 Two Rod Chains and 21 Links make 34 Rods and 84 Hundredths; expressed thus 34.84 Rods.

If the Links exceed 25 add 1 to the number of Rods and multiply the excess by 4: Thus, 15 Two Rod Chains and 38 Links make 31.52 Rods.

PROBLEM III. *To reduce Four Rod Chains to Rods and Decimal parts.*

Rule. Multiply the Chains, or Chains and Links, by 4; the Product will be Rods and Hundredths; Thus, 8 Chains and 64 Links make 34.56 Rods.

Note. The reverse of this Rule, that is, dividing by 4, will reduce Rods and Decimals to Chains and Links: Thus, 105.12 Rods make 26 Chains and 28 Links.

PROBLEM IV. *To reduce Square Rods to Acres.*

Rule. Divide the Rods by 160, and the Remainder by 40, if it exceeds that number, for Roods or Quarters of an Acre: Thus, 746 Square Rods make 4 Acres, 2 Roods and 26 Rods.

PROBLEM V. *To reduce Square Chains to Acres.*

Rule. Divide by 10; or, which is the same thing, cut off the Right hand figure: Thus, 1460 Square Chains make 146 Acres; and 846 Square Chains make 84 Acres and 6 Tenths.

PROBLEM VI. *To Reduce Square Links to Acres.*

RULE. Divide by 100000; or, which is the same thing, cut off the 5 Right hand figures: Thus, 3845120 Square Links make 38 Acres and 45120 Decimals.

Note. When the Area of a Field, by which is meant its Superficial Contents, is expressed in Square Chains and Links, the whole may be considered as Square Links, and the number of Acres, contained in the Field, found as above. Then multiply the figures cut off by 4, and again cut off 5 figures, and you have the Roods; multiply the figures last cut off by 40, and again cut off 5 figures, and you have the Rods.

EXAMPLE. How many Acres, Roods and Rods are there in 156 Square Chains and 3274 Square Links?

15)63274 Square Links
4
2)53096
40
21)23840

Answer. 15 Acres 2 Roods and 21 Rods.

* * *

PROBLEMS *for finding the Area of Right Lined Figures, and also of Circles.*

PROBLEM VII. *To find the Area of a Square or Parallelogram.*

RULE. Multiply the length into the breadth; the Product will be the Area.

PROBLEM VII. *To find the Area of a Rhombus or Rhomboides.*

RULE Drop a Perpendicular from one of the Angles to its opposite Side, and multiply that Side into the Perpendicular; the Product will be the Area.

PROBLEM IX. *To find the Area of a Triangle.*

RULE 1. Drop a Perpendicular from one of the Angles to its opposite Side, which may be called the Base; then multiply the Base by half the Perpendicular, or the Perpendicular by half the Base; the Product will be the Area. Or, multiply the whole Base by the whole Perpendicular, and half the Product will be the Area, Rule 2. If it be a Right Angled Triangle, multiply one of the Legs into half the other; the Product will be the Area. Or, multiply the two Legs into each other, and half the Product will be the Area.

Rule 3. When the three Sides of a Triangle are known, the Area may be found Arithmetically, as follows:

Add together the three Sides; from half their Sum subtract each side, noting down the Remainders; multiply the half Sum by one of those Remainders, and that Product by another Remainder, and that Product by the other Remainder; the Square Root of the last Product will be the Area.

Example. Suppose a Triangle whose three Sides are 24, 20 and 18 Chains. Demanded the Area.

24+20+18=62, the Sum of the three Sides, the half of which is 31. From 31 subtract 24, 20 and 18; the three Remainders will be 7, 11 and 13.

31×7=217; 217×11=2387; 2387×13=31031, the Square Root of which is 176.1 or 17 Acres 2 Roods and 17 Rods.

By Logarithms.

As the Addition of Logarithms is the same as the Multiplication of their corresponding Numbers; and as the Number answering to the one half of a Logarithm will be the Square Root of the Number corresponding to that Logarithm; it follows, That if the Logarithm of the half Sum of the three Sides and the Logarithms of the three Remainders be added together, the Number corresponding to one half the Sum of those Logarithms will be the Area of the Triangle.

The half Sum, 31 - -	1.49136
The first Remainder, 7 - -	0.84510
The second Remainder, 11 -	1.04139
The third Remainder, 13 -	1.11394
The Square of the Area, 31000	4.49179
Area 176 Square Chains -	2.24589

RULE 4. When two Sides of a Triangle and their contained Angle, that is, the Angle made by those Sides, are given, the Area may be found as follows.

Add together the Logarithms of the two Sides and the Logarithmic Sine of the Angle; from their Sum subtract the Logarithm of Radius, the Remainder will be the Logarithm of double the Area.

EXAMPLE. Suppose a Triangle one of whose Sides is 105 Rods and another 85 and the Angle contained between them 28° 5′. Demanded the Area.

One Side, 105	2.02119
The other Side, 85	1.92[illegible]
Sine Angle, 28° 5′	9.6[illegible]
	[illegible]
Subtract Radius	[illegible]
Double Area, 420 Rods	[illegible]

Answer. 210 Rods.

Note. Radius may be [illegible] figure of the index [illegible] setting down the [illegible]

[illegible]

[illegible]

PROB[illegible]

[illegible]

PROBL[illegible]

[illegible]

Triangles. Find the Area of each Triangle and add them together. Or, multiply the Diagonal by half the Sum of the two Perpendiculars let fall upon it, or the Sum of the two Perpendiculars by half the Diagonal; the Product will be the Area.

Note. Where the length of the four Sides and of the Diagonal is known, the Area of the two Triangles, into which the Trapezium is divided, may be calculated Arithmetically, according to PROB. IX. *Rule* 3.

PROBLEM XII. *To find the Area of a Figure containing more than Four Sides.*

RULE. Divide the Figure into Triangles and Trapezia, by drawing as many Diagonals as are necessary; which Diagonals must be so drawn as not to intersect each other: Then find the Area of each of the several Triangles or Trapezia, and add them together; the Sum will be the Area of the whole Figure.

Note. A little practice will suggest the most convenient way of drawing the Diagonals; but whichever way they are drawn, provided they do not intersect each other, the whole Area will be found the same.

PROBLEM XIII. *Respecting Circles.*

RULE 1. If the Diameter be given, the Circumference may be found by one of the following Proportions: As 7 is to 22; or more exactly, as 113 is to 355; or in Decimals, as 1 is to 3.14159; so is the Diameter to the Circumference.

RULE 2. If the Circumference be given, the Diameter may be found by one of the following Proportions: As 22 is to 7; or as 355 is to 113; or as 1 is to 0.31831; so is the Circumference to the Diameter.

RULE 3. The Diameter and Circumference being known, multiply half the one into half the other, and the Product will be the Area.

RULE 4. From the Diameter only to find the Area: Multiply the Square of the Diameter by 0.7854, and the Product will be the Area.

RULE 5. From the Circumference only to find the Area; Multiply the Square of the Circumference by 0.07958, and the Product will be the Area.

CD - - 21.50
DA - - 14.70
Diagonal AC - 28.

To protract this Trapezium.

the Side AB the given length ; with the Diag-
8 and the Side BC 11.70 describe cross Ar-
C, from A and B as Centres ; and the Point
tion will represent that Corner of the Field :
the Side CD 21.50 and the Side AD 14.70
ross Arches as at D, from A and C as Cen-
the Point of intersection will represent that
f the Field.

To find the Area.

rpendicular B a - - 11.34
— D m - - 11.10

22.44
alf Diagonal AC - - 14.00

897600
2244

Acres 31)416
4

Rood 1)664
40

Rods 26)560

Acres Rood Rods
31 — 1 — 26.56

The Perpendiculars need not be actually drawn ; their
h may be obtained as follows : From the Angle opposite
Diagonal open the Dividers so as when one Foot is in the
Point, as at B, the other, being moved backwards and
rds, may just touch the Diagonal at a, and neither go
least above or below it ; that distance in the Dividers be-
measured on the Scale will give the length of the Per-
dicular.

9600
7200
16800

Acres 17)61600
4

Roods 2)46400
40

Rods 18)56000

Acres Roods Rods
Area 17 — 2 — 18.56

Note. When there are Cyphers at the Right Hand of the Links, they may be rejected; remembering to cut off a proper number of figures according to Decimal Rules.

Observe, That in measuring with a Chain, slant or inclined Surfaces, as the Sides of Hills, should be measured horizontally, and not on the Plane or Surface of the Hill; otherwise a Survey cannot be accurately taken. To effect this, the lower end of the Chain must be raised from the ground, so as to have the whole in a horizontal Line; and the end thus raised must be directly over the Point where the Chain begins or ends, according as you are ascending or descending a Hill; which Point may be ascertained by a Plummet and Line.

CASE II.

To survey a Field in the form of a Trapezium.

Measure the several sides, and a Diagonal between two opposite Angles; protract the Field, and find the Area by PROBLEM XI. Or, without protracting the Field, calculate the Area according to the *Note* at the end of that PROBLEM.

FIELD BOOK. *See* PLATE II. *Fig.* 51.

			Ch. L.
AB	-	-	27.50
BC	-	-	11.70

					Ch. L.
AB.	N.	7°	0′	W.	28.20
BC.	N.	74	0	E.	39.50
CD.	S.	9	0	E.	38.
DE.	N.	63	20	W.	14.55
EA.	S.	74	0	W.	28.60

Acres Rood Rods
Area 117 — 1 — 6

REMARKS.

The Sides of the several Triangles into which the Plot of a Field is divided may be found by Trigonometry; and then the Area of each Triangle may be calculated acording to Prob. IX. *Rule* 3. The Sum of the Areas of the several Triangles will be the Area of the whole Field. This method may require more time but it is perfectly accurate, since no dependence is placed on the uncertain measurment of Scale and Dividers.

In the preceding Example, suppose the Field divided into three Triangles. *See Fig.* 53. In the *Triangle* EAB, the Sides EA and AB are known from the Field Book, and their contained Angle is known from the Bearing of the Sides. The other Angles and the Side EB may be found by Oblique Trigonometry, Case III; and then there will be the three Sides to find the Area. In the *Triangle* EBC, the Side BC is known from the Field Book, and the Side EB is found as above mentioned; the Angle EBA is also found as above; this subtracted from the angle ABC, which may be found from the Bearing of the Sides AB and BC, will leave the Angle EBC; there will then be two Sides and their contained Angle to find the third Side; and this being found there will be the three Sides to find the Area. In the *Triangle* EDC, the Sides DE and DC are known from the Field Book, and their contained Angle is known from the Bearing of the Sides. The Side EC and the Area may be found as above.

It is recommended to the Learner to make these calculations, as it will improve him in the knowledge of Trigonometry.

Note. Two Sides and their contained Angle being given the Area may be found by PROB. IX. *Rule* 4.

Another Method of protracting Fields.

Without drawing parallel Lines at the end of each Side, a Field may be protracted by the Angles made by the several Sides; and the Angle made between any two Sides may be found by the following RULES.

RULE 1. If the Course or Bearing of one of the Sides is Northerly and the other Southerly, one Easterly and the other Westerly subtract the less Course from the greater; the Remainder will be the Angle between them.

RULE 2. If one is Northerly and the other Southerly, and both Easterly or Westerly, add both Courses together; the Sum will be the Angle between them.

RULE 3. If both are Northerly or Southerly, and one Easterly and the other Westerly, subtract the Sum of both from 180°; the Remainder will be the Angle between them.

RULE 4. If both are Northerly or Southerly, and both Easterly or Westerly, add 90°, the less Course and the Complement of the greater together; the Sum will be the Angle between them.

To protract a Field according to the preceding Rules is preferable to the method of doing it by parallel Lines, though it may not be so easy to the Learner at first. It is difficult to draw parallel Lines with perfect accuracy, particularly without a parallel Rule; and a small deviation from a true Line may make considerable difference in the Plot of a Field.

EXAMPLE II.

FIELD BOOK *See* PLATE III. *Fig.* 58.

					Ch. L.
AB.	N.	16°	30′	E.	22.
BC.	N.	82	0	E.	19.60
CD.	S.	17	0	E.	24.
DE.	S.	37	0	W.	22.
EA.	N.	49	0	W.	25.20

Area 85 Acres.

To draw a Plot of this Field, according to the preceding RULES.

Having drawn the Side AB, according to the directions before given for laying off the first Course and Distance, compare the first and second Courses together, and they will be found to be both Northerly and both Easterly; consequently the Angle between them is found by RULE 4. as follows: 90° added to 16° 30′ the less Course and 8° the Complement of the greater, the Sum is 114° 30′ for the Angle at B. Compare the second and third Courses, and they will be found to be one Northerly and one Southerly and both Easterly; consequently, according to RULE 2. 82° the second Course added to 17° the third Course, the Sum 99° is the Angle at C. The third and fourth Courses are both Southerly and one Easterly and the other Westerly. The Angle between them at D is 126°; for 17° the third Course added to 37° the fourth Course is 54° which subtracted from 180° leaves 126°, according to RULE 3. The fourth and fifth Courses are one Southerly and the other Northerly and both Westerly. According to RULE 2. 37° the fourth Course added to 49° the fifth Course, the Sum 86° is the Angle at E.

A little practice will render this mode of protracting a Field familiar and easy; and an attention to the Courses will show in what direction the Angle is to be made.

EXAMPLE III.

FIELD BOOK. *See* PLATE IV. *Fig.* 66.

					Ch. L
AB.	N.	56°	15′	E.	21.60
BC.	N.	26	30	E.	13.44
CD.	S.	71	30	E.	18.96
DE.	S.	26	30	E.	13.44
EF.	S.	71	30	W.	18.96
FG.	S.	45	0	E.	8.47
GH.	S.	63	30	E.	13.44
HI.	N.	45	0	E.	8.47
IK.	S.	26	30	E.	13.44
KL.	S.	45	0	W.	8.47

LM.	S.	63	30	W.	13.44
MN.	N.	76	0	W.	24.73
NA.	N.	36	45	W.	30.

Acres. Rood Rods
Area 167 — 1 — 30

The above Field may be protracted, and its Area calculated according to the directions given in the preceding EXAMPLES.

A RULE *to determine whether the Courses in any Survey have been accurately taken.*

By the RULES for protracting a Field, *Page* 48, find the Quantity of the several Angles, and add the whole together ; to their Sum add 360° ; divide this Sum by 180° ; and, if the Survey is right, the Quotient will equal the number of Angles contained in the Field. Thus, in the preceding EXAMPLE, the Sum of all the Angles is 1980° ; to this add 360° and it makes 2340° ; this Sum being divided by 180° the Quotient will be 13, which is the number of Angles in the Field. *See the Figure.*

When the Angle is without the Field, as at B, F, G and H, substract the Quantity of the Angle, as found by the preceding directions, from 360 and make use of the Remainder in adding the several Angles. Thus the Angle at B 150° 15′ must be subtracted from 360°, and the Remainder 209° 45′ considered as the real Quantity of that Angle. If there is an error, the Field must be re-surveyed, and the error corrected, else the true Area cannot be ascertained.

Note. Directions will be given in SECTION III. for determining whether the Sides have been accurately measured.

Demonstration of the preceding Rule.

Suppose a Plot of a Field, as ABCD, &c. PLATE II. *Fig.* 54. From some Point within the Field, as at a, draw Lines to the several Angles; and it is evident the whole will be divided into as many Triangles as there are Sides to the Field, that is 7. Now, as the three Angles of every Triangle amount to 180°, the Sum of the Angles of all these Triangles will be 7 times 180°, that is 1260°. The Sum of the Angles at the Centre is 360°, because the Arches which measure those Angles form a Circle. Therefore, 360° the Sum of those central Angles, substracted from 1260° will leave the Sum of all the other Angles; which are the Angles made by the several Sides of the Field. The Angles of this Field will be found to contain 900°; if to this you add 360° and divide the Sum, viz. 1260° by 180° the Quotient will be 7, the number of the Sides or Angles of the Field.

Several Field Books to exercise the Learner in plotting Fields and calculating their Area.

No. I.

					Rods.
1.	N.	15°	0′	E.	320
2.	N.	37	30	E.	160
3.	East				120
4.	S.	11	0	E.	200
5.	South				216
6.	West				160
7.	S.	36	30	W.	160
8.	N.	38	15	W.	136
	Acres		Roods		Rods
Area	744	—	3	—	28

No. II.

					Ch. L.
1.	N.	75°	0′	E.	13.70
2.	N.	20	30	E.	10.30
3.	East				16.20
4.	S.	33	30	W.	35.30
5.	S.	76	0	W.	16.
6.	North				9.
7.	S.	84	0	W.	11.60
8.	N.	53	15	W.	11.60
9.	N.	36	45	E.	19.20
10.	N.	22	30	E.	14.
11.	S.	76	45	E.	12.
12.	S.	15	0	W.	10.85
13.	S.	16	45	W.	10.12
	Acres		Roods		Rods
Area	110	—	2	—	23

No. III.

					Rods.
1.	S.	65°	40′	W.	49.7
2.	S.	67	15	W.	34.5
3.	S.	54	0	W.	17.9
4.	S.	20	0	W.	5.8
5.	S.	7	30	E.	29.4
6.	N.	83	0	E.	107.4
7.	N.	5	50	W.	22.
8.	N.	18	30	W.	46.
	Acres		Rood		Rods
Area	34	—	1	—	19

No. IV.

					Rods.
1.	N.	43°	0′	W.	12.44
2.	N.	64	0	W.	8.
3.	N.	52	0	W.	14.60
4.	N.	37	5	W.	51.36
5.	N.	15	30	W.	21.76
6.	N.	20	40	W.	44.60
7.	N.	88	20	E.	167.60
8.	S.	34	40	E	71.20
9.	S.	75	0	W.	69.72
10.	S.	55	0	W.	64.60
11.	S.	25	0	W.	18.12
	Acres		Roods		Rods
Area	97	—	2	—	29

NO. V.

					Rods.
1.	S.	11°	50′	W.	34.6
2.	S.	63	20	E.	93.6
3.	N.	4	0	W.	34.9
4.	S.	89	55	E.	40.1
5.	N.	5	20	W.	35.5
6.	N.	69	40	W.	60.
7.	S.	78	0	W.	30.6
8.	N.	67	20	W.	1.2
9.	S.	72	30	W.	10.4
10.	S.	66	55	W.	15.2

Acres Rood Rods
Area 41 — 1 — 34

NO. VI.

					Rods.
1.	S.	34°	0′	E.	42,8
2.	S.	29	0	E.	69.4
3.	S.	64	50	W.	53.
4.	S.	25	0	E.	4.
5.	S.	66	30	W.	39.
6.	N.	25	0	W.	4.
7.	S.	64	45	W.	32.2
8.	N.	30	30	W.	18.3
9.	N.	56	30	E.	34.5
10.	N.	64	0	E.	12.5
11.	N.	49	0	E.	14.
12.	N.	26	10	W.	19.3
13.	N.	21	0	W.	18.3
14.	N.	44	10	W.	18.
15.	N.	64	40	E.	30.5
16.	N.	18	30	W.	39.
17.	N.	86	5	E.	26.7

Acres Rood Rods
Area 48 — 1 — 12

NO. VII.

					Ch. L.
1.	N.	0°	45′	W.	9.
2.	N.	19	30	W.	5.35
3.	N.	23	0	W.	4.09
4.	N.	41	35	W.	6.15
5.	N.	3	0	W.	36.75
6.	S.	86	50	W.	13.33
7.	N.	2	15	W.	17.65
8.	N.	85	45	E.	12.56
9.	S.	2	10	E.	8.
10.	N.	86	45	E.	7.38
11.	S.	3	15	E.	13.20
12.	N.	87	0	E.	29.92
13.	N.	49	20	E.	4.04
14.	North				2.23
15.	N.	50	35	E.	6.50
16.	S.	22	50	E.	17.94
17.	S.	34	0	W.	3.50
18.	S.	41	0	W.	3.
19.	S.	22	50	W.	9.25
20.	S.	3	40	E.	2.64
21.	S.	86	0	W.	2.50
22.	S.	0	25	W.	14.50
23.	S.	2	0	W.	5.38
24.	S.	10	0	E.	11.75
25.	S.	86	0	W.	34.60

Acres Roods Rods
Area 268 — 3 — 7

NO. VIII.

					Rods.
1.	S.	6°	30′	E.	19.1
2.	S.	63	30	E.	14.36
3.	S.	67	0	E.	10.68
4.	N.	88	0	E.	13.3
5.	S.	31	30	W.	32.44
6.	S.	31	55	W.	96.5
7.	S.	33	25	W.	34.9
8.	S.	20	45	E.	3.68
9.	S.	16	15	W.	64.
10.	N.	52	30	W.	12.8
11.	S.	45	0	W.	18.24
12.	S.	69	0	W.	21.4
13.	S.	12	40	W.	9,4
14.	S.	84	20	W.	9.5
15.	N.	22	15	W.	24.
16.	North				9.8
17.	N.	29	15	W.	30.6
18.	N.	44	25	W.	21.8
19.	N.	61	30	W.	23.1
20.	N.	41	0	W.	10.8
21.	N.	36	0	E.	41.56
22.	S.	68	0	E.	80.6
23.	N.	44	30	E.	20.4
24.	N.	2	30	W.	41.
25.	N.	14	45	W.	62.32
26.	N.	16	0	W.	14.8
27.	N.	1	45	W.	14.8
28.	N.	82	30	E.	99.

Acres Rood Rods
Area 135 — 1 — 15

CASE [illegible]

To [illegible] a Field [illegible] in the Field [illegible]

Take the B[illegible] Distance from the Station.

FIELD BOOK [illegible]

From Station [illegible] [illegible]

[illegible]

Draw a Meridian [illegible] in that Line [illegible] tance to [illegible] Angle to [illegible]

To find the Area.

The Area [illegible] XII. by [illegible] more acc[illegible]

As the Bearing [illegible] Station to the [illegible] their contained [illegible] into which the [illegible] be readily [illegible]

Note. [illegible]

Triangle [illegible]

aA. [illegible]

aB. [illegible]

Sine A[illegible] [illegible]

Doub. Area [illegible]

Triangle [illegible]

aB. [illegible]

aC. [illegible]

Sine B[illegible] [illegible]

Doub. Area [illegible]

Triangle aEF.	
aE, 12 - -	1.07918
aF, 8.78 - -	0.94349
Sine EaF, 55° -	9.91336
Doub. Area, 86.3	1.93603

Triangle aFA.	
aF, 8.78 - -	0.94349
aA, 8.70 -	0.93952
Sine FaA, 45° -	9.84948
Doub. Area, 54	1.73249

Triangle	aAB	-	85.7
	aBC	-	51.8
	aCD	-	117.
	aDE	-	122.
	aEF	-	86.3
	aFA	-	54.
Double Area		-	516.8 Square Chains.

Area - 25)84
4

3)36
40

14)40

	Acres		Roods		Rods
Area	25	—	3	—	14.4

CASE VI.

To survey a Field from some one of the Angles, from which the others may be seen.

From the stationary Angle take the Bearing and Distance to each of the other Angles, with a Compass and Chain.

FIELD BOOK. *See* Plate III. *Fig.* 59.

				Ch. L.
FG.	N.	70°	W.	14.60
FA.	N.	50	W.	18.20
FB.	N.	30	W.	16.80
FC.	N.	10	W.	21.20
FD.	N.	7	E.	16.95
FE.	N.	30	E.	8.50

To draw a Plot of this Field.

Draw a Meridian Line to pass through the stationary Angle, as at F. From the Point F lay off the Bearing and Distance to the several Angles, and connect them by Lines, as FG, FA, FB, &c.

The Area may be calculated as taught in the preceding CASE.

CASE VII.

To survey a Field from two Stations within the Field, provided the several Angles can be seen from each Station.

Find the Bearing from each Station to the respective Angles; and also the Bearing and Distance from one Station to the other.

FIELD BOOK. *See* PLATE III. *Fig.* 62.

First Station	*Second Station.*
AC. N. 38° 30′ E.	BC. S. 82° 0′ E.
AD. S. 69 0 E.	BD. S. 17 0 E.
AE. S. 59 0 W.	BE. S. 23 0 W.
AF. N. 63 0 W.	BF. S. 49 0 W.
AG. N. 21 0 W.	BG. N. 76 0 W.
AH. North.	BH. N. 24 0 W.

Stationary Line AB. N. 14° E. 20 Chains.

To protract this Field.

At the first Station A draw a Meridian Line and lay off the Bearings to the respective Angles; draw the stationary Line AB, according to the Bearing and Distance; at B draw a Meridian Line parallel to the other, and lay off the Bearings to the Angles, as taken from this Station; from each Station draw Lines through the Degree which shows the Bearing of each Angle, as marked by the Protractor or Line of Chords, and the Points where those Lines intersect each other will be the Angles of the Field. Connect those angular Points together by Lines, and those Lines will represent the several Sides of the Field.

CASE VIII.

To survey an inaccessible Field.

Fix upon two Stations, at a convenient distance from the Field, from each of which the several Angles may be seen; from each Station take the Bearing of the Angles; and take the Bearing and Distance from one Station to the other.

FIELD BOOK. *See* Plate IV. *Fig.* 67.

First Station.	*Second Station.*
AE. N. 9° 15′ E.	BE. N. 50° 0′ W.
AF. N. 16 0 E.	BF. N. 29 15 W.
AG. N. 14 30 E.	BD. N. 24 0 W.
AD. N. 39 0 E.	BG. N. 21 30 W.
AH. N. 40 0 E.	BH. N. 5 0 E.
AC. N. 72 0 E.	BC. N. 20 30 E.

Ch. L.
Stationary Distance AB, S. 88° 30′ E. 19.20

The directions given in the last Case for plotting the Field, will apply in this Case also; and the Area in this and the preceding Case may be calculated in the manner pointed out in Case IV. by dividing the Plot into Triangles and measuring Diagonals and Perpendiculars. Or the Sides may be found by Trigonometry, and the Area calculated Arithmetically, as already taught.

CASE IX.

To survey a Field where the boundary Lines are very irregular, without noticing with the Compass every small Bend.

Begin near one Corner of the Field, as at A, Plate IV. *Fig.* 68. and measure to the next large Corner, as B, in a straight Line; noticing also the Bearing of this Line. From the Line take Offsets to the several Bends, at Right Angles from the Line; noticing in the Field Book at what part of the Line they are taken, as A 1, H 2, I 3, B 4. Proceed in the same manner round the Field. In the *Figure* the dotted Lines represent the stationary Lines, and the black Lines the Boundaries of the Field.

FIELD BOOK.

Bearing and Distance.	Offsets	Bearing and Distance.	Offsets
Ch. L.	Ch. L.	Ch. L.	Ch. L.
AB. N. 85° 0′ E. 11.20	0.56	EF. S. 67° 50′ W. 8.20	0.40
at 5.40	1.40	at 1.4	0.36
8.26	0.36	2.96	0.33
the end	0.36	5.88	1.
BC. N. 7° 20′ E. 7.96	0.20	the end	0.12
at 2.36	0.36	FG. S. 27° 40′ E. 7.06	1.20
4.28	0.96	at 2.	0.24
the end	0.30	the end	0.16
CD. N. 63° 0′ W. 4.68		GA. S. 25° 20′ W. 6.48	
at 4.34	0.30	at 3.80	0.80
DE. N. 11° 10′ W. 4.20	0.30	the end	0.40

To protract this Field.

Draw the stationary Lines according to the directions in Case IV. From A make an Offset of 56 Links to 1; measure from A to H 540 Links and make the Offset H 2, 140 Links; measure from A to I 826 Links and make the Offset I 3, 36 Links: at B make the Offset B 4, 36 Links. Proceed in the same manner round the Field, and connect the ends of the Offsets by Lines, which will represent the Boundaries of the Field.

To find the Area.

Find the Area within the Stationary Lines as before taught; then of the several small Trapezoids, Parallelograms and Triangles made by the stationary Lines, Offsets and boundary Lines, and add the whole together: Thus, add 56 Links the Offset A 1 to 140 Links the Offset H 2 and multiply their sum 196 by half 540 the length of the Line AH, and the Product 52920 Square Links will be the Area of the Trapezoid AH21: Again, add 140 the Offset H2 to 36 the Offset I3 and multilpy their Sum 176 by half 286 the length of the

Line HI, and the product 25168 Square Links will be the Area of the Trapezoid HI32. Proceed in the same manner to calculate the Area of all the Trapezoids, Triangles, &c.

CASE X.

To survey a Field by taking Offsets both to the Right and Left; that is, within and without the Field, as occasion shall require, in consequence of the Stationary Lines crossing the boundary Lines: Also, by Intersections, that is, taking the Bearing of an inaccessible Corner from two Stations.

The directions given in the preceding Case, together with the following Field Book, will show the Learner how to survey a Field like the following, and also to protract it when surveyed.

FIELD BOOK. *See* Plate IV. *Fig.* 69.

Offsets to the Left.	Bearing and Distance.	Offsets to the Right.	Remarks.
	Ch. L.	Ch. L	A Tower bears from A. N. 48°. W.
Ch.L	AB. N. 88° 0′ W. 22.12		
1.12	at 4.25		
3.40	7.40		
1.25	13.		
	BC. N. 27° 45′ W. 21.12		From B the Tower bears N. 38° 30′ E.
	at 4.10	1.20	
	10.25	1.15	
0.45	15.		
	C 1. S. 82° 15′ E. 5.45		From C go into the Field to 1, on account of some impediment on or near the boundary Line. At D, you get into another Corner of the Field.
	1,2. N. 70 0 E. 13.25		
	2 D. N. 20 0 E. 3.36		
	DF. S. 35° 0′ E. 15.15		E an inaccessible Corner bears from D. S. 65° 30′ E.
	FA. S. 15° 15′ E. 15.10		E the inaccessible Corner bears from F N. 4° W.
2.20	at 1.20		
2.32	7.45		
	12.25	0.36	

Note. To draw a Tree, House, Tower, or any other remarkable object, in its proper place, in the Plot of a Field—From any two Stations, while surveying the Field, take the Bearing of the object; and the intersection of the Lines, which represent the Bearings, will determine the place of the object; in the same manner that the Tower is drawn in the Figure.

To find the Area of the above Field.

Find the Area within the stationary Lines, and then of the several small Trapezoids, &c. remembering to distinguish those without the stationary Lines from those which are within. Subtract the Area of those within the stationary Lines from the Area of those without, and add the Remainder to the Area contained within the stationary Lines; the sum will be the whole Area of the Field.

SECTION III.

REGTANGULAR SURVEYING, *or an accurate method of calculating the Area of a Field Arithmetically, from the* FIELD BOOK, *without the necessity of protracting it, and measuring with a Scale and Dividers, as is commonly practised.*

1. Survey the Field, in the usual method, with an accurate Compass and Chain; and from the FIELD BOOK set down, in a Traverse Table, the Course or Bearing of the several Sides, and their length in Chains and Links, or Rods and Decimal parts of a Rod; as in the 2d and 3d Columns of the following EXAMPLE.

EXAMPLE I.

No.	Courses	dis ch	N.	S.	E.	W.	1 Dep. Col.	2 Dep. Col.	North Areas	South Areas
1	N. 15° 0′ E.	80	77.27 77.15	. . .	20.71 20.74	. . .	20.74	20.74	1600.0910	. . . . .
2	N. 37 30 E.	40	31.73 31.66	. . .	24.35 24.38	. . .	45.12	65.86	2085.1276	. . . . .
3	East	30	. . .	. . .	30. 0 30.04	. . .	75.16	120.28	. . . .	. . . . .
4	S. 11 0 E.	50	. . .	49.08 49.15	9.54 9.56	. .	84.72	159.88	. . .	7858.1020
5	South	54	. . .	54. 0 54.10	. . .	. .	84.72	169.44	. . . .	9166.7040
6	West	40	. . .	. . .	. . .	40. 0 39.95	44.77	129.49	. . . .	. . . . .
7	S. 36 30 W.	40	. . .	32.15 32.21	. . .	23.79 23.75	21.02	65.79	. . . .	2119.0959
8	N. 38 15 W.	34	26.70 26.65	. . .	. . .	21.05 21.02	0. 0	21.02	560.1830	. . . . .
			135.70 135.46	135.23 135.46	84.60 84.72	84.84 84.72			4245.4016	19143.9019

19143.9019 Sum of South Areas
4245.4016 North Do.

2)14898.5003 Double Area of the Field

Acres 744)92501 Area
4

Roods 3)70004
40

Rods 28)00160 Area 744 — 3 — 28 (Acres Roods Rods)

2. Calculate by RIGHT ANGLED TRIGONOMETRY, CASE I. or find by the Table of Difference of Latitude

and Departure,* or by the Table of Natural Sines,† the Northing or Southing, Easting or Westing made on each Course, and set them down against their several Courses, in their proper Columns, marked N. S. E. W.

Note. To determine whether the Latitude and departure for any particular Course and Distance are accurately calculated, square each of them; and if they are right, the Sum of their Squares will equal the Square of the Distance, for the following reason: The Latitude and Departure represent the two Legs of a Right Angled Triangle, and the Distance the Hypothenuse; and it is a Mathematical truth, that the Square of the Hypothenuse of any Right Angled Triangle is equal to the Sum of the Squares of the two Legs.

3. If the Survey has been accurately taken, the Sum of the Northings will equal the Southings; and the Eastings will equal the Westings. If upon adding up the respective Columns, these are found to differ very considerably, the Field should be again surveyed; as some error must have been committed either in taking the Courses or measuring the Sides.‡ If the difference is small, a judicious, experienced Surveyor will judge from the nature of the ground or shape of the Field surveyed, where the mistake was most probably made, and will correct accordingly. Or, the Northings and Southings, and the Eastings and Westings may be equalled by balancing them, as follows: Subtract one half the difference from that Column which is the largest, and add the other half to that Column which is the smallest; and let the difference to be added or subtracted be divided among the several Courses according to their length.

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* For an Explanation of this Table, and the manner of using it, see the Remarks preceding the Table.

† See the Remarks preceding the Table of Natural Sines.

‡ A method of determining whether the Courses are right has been already explained. *See page* 50. The Surveyor, before he leaves the Field, should calculate the Northings, Southings, &c. and if he finds much difference determine whether the Courses are right. This will show him whether a re-survey is necessary, and will enable him to ascertain whether the error lies in the Courses or Distances.

In EXAMPLE I. the upper numbers are the northings, &c. as found by a Table of Difference of Latitude and Departure. The several Columns being added, the Northings are found to exceed the Southings 47 Links; and the Westings to exceed the Eastings 24 Links. They may be balanced by taking 24 Links from the Northings, and adding 23 Links to the Southings; and taking 12 Links from the Westings and adding 12 Links to the Eastings. Take from the first Course of the Northings 12 Links, from the second 7, and from the third 5; to the first Southing add 7 Links, to the second 10, and to the third 6: Add to the first Easting 3 Links, to the second 3, to the third 4, and to the fourth 2; take from the first Westing 5 Links, from the second 4, and from the third 3. The lower numbers will then represent the Northings, &c. as balanced.

4. These Columns being balanced, proceed to form a Departure Column, or a Column of Meridian Distances; which shows how far the end of each Side of the Field is East or West of the Station where the calculation begins. This Column is formed by a continual addition of the Eastings and subtraction of the Westings; or by adding the Westings and subtracting the Eastings: *See* EXAMPLE I.

The first Easting 20. 74 is set for the first number in the Departure Column; to this add 24.38 the second Easting, and it makes 45.12 for the second number; to this add 30.04 the third Easting, and it makes 75.16 for the third number; to this add 9.56 the fourth Easting, and it makes 84.72 for the fourth number; the fifth Course being South, it is evident the Meridian Distance will remain the same, therefore place against it the same Easting as for the preceding Course; from this subtract 39.95 the first Westing, and it leaves 44.77 for the sixth Course; from this subtract 23.75 the second Westing, and it leaves 21.02 for the seventh Course; from this subtract 21.02 the last Westing, and it leaves 0.0 to be set against the last course, which shows that the additions and subtractions have been accurately made. For as the Eastings and Westings equal each other, it is evident that one being added and the other subtracted, there will in the end be no Remainder.

5. The next step in the process is to form a second departure Column, the numbers in which show the Sum of the Meridian Distances at the end of the first and second, second and third, third and fourth Courses, &c.

The first number in this Column will be the first in the other Departure Column; to which add the second number in that Column for the second in this; for the third add the second and third; and for the fourth the third and fourth; and so on till the Column be completed. *See* EXAMPLE I.

The first number to be placed in the second Departure Column is 20.74; to this add 45.12 and it makes 65.86 for the second number; to 45.12 add 75.16 and it makes 120.28 for the third number; to 75.16 add 84 72 and it maks 159.88 for the fourth number; to 84. 72 add 84.72 and it mades 169.44 for the fifth number; to 84.72 add 44.77 and it makes 129.49 for the sixth number; to 44.77 add 21.02 and it makes 65.79 for the seventh number; to 21.02 add 0.0 and it makes 21.02 for the eighth number.

6. When the work is thus far prepared, multiply the several numbers in the second Departure Column, by the Northings or Southings standing against them respectively; place the Products of those multiplied by the Northings in the Column of North Areas, and of those multiplied by the Southings in the Column of South Areas; add up these two Columns and subtract the less from the greater; the Remainder will be double the Area of the Field, in Square Rods or Square Chains and Links, whichever measure was used in the Survey.

Demonstration of the preceding Rules. *See* PLATE III. *Fig* 63. *and* EXAMPLE I.

The dotted Line A 2 represents the Northing, and the Line 2 B the Easting made by the first Course: These multiplied together, that is, 77.15×20.74 =1600.0910, which is double the Area of the Triangle A 2 B, as is evident from the Rule to find the Area of a Triangle, PROB. IX. *Rule* 1. This number is to be placed for the first number in the Column of North Areas. The Line 3 C represents the Sum of the Eastings made by the first and second Courses, which is 45.12 the second number in the first Departure Column; if to this you add 20.74 the length of the Line 2 B you have 65.86, which is the second number in the second Departure Column, and which represents the Sum of the two Lines 3 C and 2B. These two Lines with the Line 2, 3 which represents the Northing made by the second course, and the Line BC, one of the Sides of the Field, form a Rigt Angled Trapezoid. Now, by the Rule to find the Area of such a Trapezoid, *See* PROB. X. 65.86×31.66=2085.1276, double the Area of the Trapezoid 2 BC 3. Place this Product for the second number in the Column of North Areas.

To the Line 3 C add CD 30.04 the Easting made by the third Course, and you have 75.16 which is the Sum of the Eastings made by the three first Courses, and the third number in the first Departure Column. To this add 9.56 the Easting of the fourth Course, and you have 84.72 the length of the line 1 E, which represents the Sum of the Eastings made by the four first Courses, and is the fourth number in the first Departure Column. These two, viz. the Lines 3 D 75.16 and 1 E 84.72 added together make 159.88 the fourth number in the second Departure Column; which being multiplied by 49.15 the length of the Line 3, 1 which represents the Southing made by the fourth Course, will give double the Area of the Trapezoid 1 ED 3. The number thus produced is 7858.1020, which is to be placed for the first number in the Column of South Areas.

The fifth Course being due South, it is evident the Sum of the Eastings will remain the same as at the end of the fourth Course: That is, the Line 4 F equals the Line 1 E, which is 84.72. These added make 169.44 the fifth number in the second Departure Column. This being multiplied by 54.10 the length of the Line

EF, which is the Southing of the fifth Course, as corrected in balancing, and the same as the Line 1, 4—will give double the Area of the Parallelogram 1EF4, which is 9166.7040 the second number in the Column of South Areas.

From the Line 4F 84.72 subtract 39.95 which is a West Course, and it leaves 4G 44.77 the Sum of the Eastings, or the Meridian Distance, at the end of the sixth Course, and the sixth number in the first Departure Colume. From this subtract 23.75 the Westing made by the seventh Course, and you have 21.02 the length of the Line 5H, which is the Meridian Distance at the end of the seventh Course, and the seventh number in the first Departure Column. The Line 4G 44.77 added to the Line 5H 21.02 make 65.79 the seventh number in the second Departure Column. This being multiplied by 32.21 the length of the Line 4, 5—which is the Southing of the seventh Course, will give double the Area of the Trapezoid 4GH5, which is 2119.0959 the third number in the Column of South Areas.

The Line H5, 21.02 is the Westing of the last Course, and the last number in the second Departure Column. This being multiplied by 26.65 the length of the Line 5A, and the Northing of the last Course, produces 560.1830, which is double the Area of the Triangle A5H, and the last number in the Column of North Areas.

Note. It will be observed that against the third and sixth Courses there are no Areas; the reason is that these Courses being one East and the other West, there is no Northing or Southing to be multiplied into them; regard can therefore be had to them only in forming the Departure Columns.

By inspecting the *Figure*, and attending to the preceding illustrations, it will be seen that the three North Areas represent double the Area of the Triangle A2B, the Trapezoid 2BC3, and the Triangle A5H, all of which are without the boundary Lines of the Field: Also, that the three South Areas represent double the Area of the Trapezoid 3DE1, the Parallelogram 1EF4, and the Trapezoid 4GH5; and that these include not only the Field but also what was included in the North Areas. Therefore the North Areas subtracted from the South, the Remainder will be double the Area of the Field, contained within the black Lines.

Additional Directions and Explanations.

The Northings and Southings may be added and subtracted instead of the Eastings and Westings; then there will be two Latitude Columns instead of Departure Columns; and the numbers in the second Latitude Column must be multiplied into the Eastings and Westings, and you will have East and West Areas.

When the Course is directly North or South, the Distance must be set in the North or South Column; when East or West, in the East or West Column. There will therefore sometimes be no number to be added to or subtracted from the number last set in the Latitude or Departure Column; then the number last placed in the Column must be brought down and set against such Course; as in EXAMPLE I. at the 5th Course. It may also sometimes be the Case that there will be no number to multiply into the number in the second Latitude or Departure Column; then that number must be omitted, and against such Course there will be no Area; as in EXAMPLE I. at the 3d and 6th Courses.

When the Northings or Southings, Eastings or Westings, beginning at the top, will not admit of a continual addition of the one and subtraction of the other, without running out before you get through the several Courses, you may begin at such a Course as will admit of a continual addition and subtraction; and when you get to the bottom go to the top, and you will end in Cypher at the Course next above that where you began; as in EXAMPLE II. which begins at the 9th Course to add the Eastings and subtract the Westings.

Dist.	10° 0′		10° 15′		10° 30′		10° 45′		Dist.
	Lat.	Dep.	Lat.	Dep	Lat.	Dep.	Lat.	Dep.	
1	0.98	0.17	0.98	0.18	0.98	0.18	0.98	0.19	1
2	1.97	0.35	1.97	0.36	1.97	0.36	1.96	0.37	2
3	2.95	0.52	2.95	0.53	2.95	0.55	2.95	0.56	3
4	3.94	0.69	3.94	0.71	3.93	0.73	3.93	0.75	4
5	4.92	0.87	4.92	0.89	4.92	0.91	4.91	0.93	5
6	5.91	1.04	5.90	1.07	5.90	1.09	5.89	1.12	6
7	6.89	1.22	6.89	1.25	6.88	1.28	6.88	1.31	7
8	7.88	1.39	7.87	1.42	7.87	1.46	7.86	1.49	8
9	8.86	1.56	8.86	1.60	8.85	1.64	8.84	1.68	9
10	9.85	1.74	9.84	1.78	9.83	1.82	9.82	1.87	10
11	10.83	1.91	10.82	1.96	10.82	2.00	10.81	2.05	11
12	11.82	2.08	11.81	2.14	11.80	2.19	11.79	2.24	12
13	12.80	2.26	12.79	2.31	12.78	2.37	12.77	2.42	13
14	13.79	2.43	13.78	2.49	13.77	2.55	13.75	2.61	14
15	14.77	2.60	14.76	2.67	14.75	2.73	14.74	2.80	15
16	15.76	2.78	15.74	2.85	15.73	2.92	15.72	2.98	16
17	16.74	2.95	16.73	3.03	16.72	3.10	16.70	3.17	17
18	17.73	3.13	17.71	3.20	17.70	3.28	17.68	3.36	18
19	18.71	3.30	18.70	3.38	18.68	3.46	18.67	3.54	19
20	19.70	3.47	19.68	3.56	19.67	3.64	19.65	3.73	20
21	20.68	3.65	20.66	3.74	20.65	3.83	20.63	3.92	21
22	21.67	3.82	21.65	3.91	21.63	4.01	21.61	4.10	22
23	22.65	3.99	22.63	4.09	22.61	4.19	22.60	4.29	23
24	23.64	4.17	23.62	4.27	23.60	4.37	23.58	4.48	24
25	24.62	4.34	24.60	4.45	24.58	4.56	24.56	4.66	25
26	25.61	4.51	25.59	4.63	25.56	4.74	25.54	4.85	26
27	26.59	4.69	26.57	4.80	26.55	4.92	26.53	5.04	27
28	27.57	4.86	27.55	4.98	27.53	5.10	27.51	5.22	28
29	28.56	5.04	28.54	5.16	28.51	5.29	28.49	5.41	29
30	29.54	5.21	29.52	5.34	29.50	5.47	29.47	5.60	30
31	30.53	5.38	30.51	5.52	30.48	5.65	30.46	5.78	31
32	31.51	5.56	31.49	5.69	31.46	5.83	31.44	5.97	32
33	32.50	5.73	32.47	5.87	32.45	6.01	32.42	6.16	33
34	33.48	5.90	33.46	6.05	33.43	6.20	33.40	6.34	34
35	34.47	6.08	34.44	6.23	34.41	6.38	34.39	6.53	35
36	35.45	6.25	35.43	6.41	35.40	6.56	35.37	6.71	36
37	36.44	6.43	36.41	6.58	36.38	6.74	36.35	6.90	37
38	37.42	6.60	37.39	6.76	37.36	6.93	37.33	7.09	38
39	38.41	6.77	38.38	6.94	38.35	7.11	38.32	7.27	39
40	39.39	6.95	39.36	7.12	39.33	7.29	39.30	7.46	40
41	40.38	7.12	40.35	7.30	40.31	7.47	40.28	7.65	41
42	41.36	7.29	41.33	7.47	41.30	7.65	41.26	7.83	42
43	42.35	7.47	42.31	7.65	42.28	7.84	42.25	8.02	43
44	43.33	7.64	43.30	7.83	43.26	8.02	43.23	8.21	44
45	44.32	7.81	44.28	8.01	44.25	8.20	44.21	8.39	45
46	45.30	7.99	45.27	8.19	45.23	8.38	45.19	8.58	46
47	46.29	8.16	46.25	8.36	46.21	8.57	46.18	8.77	47
48	47.27	8.34	47.23	8.54	47.20	8.75	47.16	8.95	48
49	48.26	8.51	48.22	8.72	48.18	8.93	48.14	9.14	49
50	49.24	8.68	49.20	8.90	49.16	9.11	49.12	9.33	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	80° 0′		79° 45′		79° 30′		79° 15′		

The Area against the 13th Course is the Trapezoid 6AN5, part within and part without the Field.

The Area against the 1st Course is the Trapezoid 6AB7, part within and part without the Field. This is a North Area and to be ultimately subtracted from the South Areas; but this includes a part of the preceding South Area, *viz.* the space nAso; it will however be seen hereafter that this same space is included in another South Area. This North Area contains also a part of the first North Area, *viz.* the space 6no7; but the same space is also included in another South Area.

The Area against the 2d Courses is also a North Area, and is the Trapezoid 7BC8. This Trapezoid contains the space sBCx, without the Field; the space osxw, within the Field; and the space 7ow8, without the Field. But the space osxw will be contained in the next South Area; and the space 7ow8, which was contained in the two first North Areas, will be contained in the next South Area.

By examining the whole *Figure*, in this manner, it will be seen that the North Areas contain all without the Field that is taken into the Calculation, and some of it twice over; they also contain part of the Area within the Field. The South Areas contain all within the Field, and all without the Field that is contained in the North Areas. They also contain, twice over, so much of the Field as is included in any of the North Areas; and likewise, twice over, that part without the Field which is contained twice in the North Areas. So that subtracting tne North from the South Areas leaves double the Area of the Field.

This method of calculating the Area of a Field by the Northings, Southings, Eastings and Westings, divides the Field, with a certain quantity of the adjoining ground, into Right Angled Triangles, Right Angled Trapezoids, Parallelograms, or Squares, as may be seen by the *Figures*. It may therefore with propriety be called RECTANGULAR SURVEYING.

A USEFUL PROBLEM.

To find the true Area of a Field which has been measured by a Chain too long or too short.

Calculate the Area as if the Chain was of a true length, then institute the following Proportion:

As the Square of the length of the true Chain;
Is to the Area, as found by the Chain made use of;
So is the Square of the length of that Chain;
To the true Area of the Field.

EXAMPLE.

Suppose a Field, measured by a Two Rod Chin 3 Inches too long, is found to contain 41 Acres 1 Rood and 33 Rods, what is the true Area?

As the Square of 33 Feet, the true length of a Two Rod Chain; Is to 41 Acres 1 Rood and 33 Rods; So is the Square of 33 Feet 3 Inches; the length of the Chain used in the Survey; To 42 Acres and 13 Rods. 33 Feet=396 Inches. 396×396=156816 Square Inches.

41 Acres 1 Rood 33 Rods=6633 Rods.

33 Feet 3 Inches=399 Inches. 399×399=159201 Square Inches.

159201×6633÷156316=6733 Rods.

6733÷160=42 Acres 13 Rods, the true Area.

PART II.

LAYING OUT LAND.

PROBLEM I. *To lay out any number of Acres in the form of a Square.*

Annex 5 Cyphers to the number of Acres, which will turn them into Square Links, the Square Root of which will be the Side of the Square in Links.

EXAMPLE. It is required to lay out 810 Acres in the form of a Square.

Answer. Each Side of the Square must be 9000 Links, or 90 Chains.

PROBLEM II. *To lay out any number of Acres in the form of a Parallelogram, whereof one Side is given.*

Divide the number of Acres, when turned into Square Links, by the given Side; the Quotient will be the Side required.

EXAMPLE. What must be the longest side of a Parallelogram, which is to contain 25 Acres, when the shortest side is 5 Chains and 50 Links?

Answer. 2500000÷550=4545 Links for the longest Side.

PROBLEM III. *To lay out any number of Acres in a Field, 3, 4, 5, 6, &c. times as long as it is broad.*

Divide the Acres, when turned into Square Links, by the proportion between the length and breadth; the Square Root of the Quotient will be the shortest Side.

EXAMPLE. It is required to lay out 100 Acres 5 times as long as it is broad.

Answer. 10000000÷5=2000000 the Square Root of which is 1414 Links for the shortest Side, and the longest will be 7070 Links.

PROBLEM IV. *To make a Triangle which shall contain a given number of Acres, being confined to a certain Base.*

Double the given number of Acres, to which annex 5 Cyphers, and divide by the Base; the Quotient will be the Perpendicular in Links.

EXAMPLE. Upon a Base of 40 Chains to lay out 100 Acres in a Triangular from.

Answer. 5000 Links or 50 Chains will be the length of the Perpendicular.

The Perpendicular may be erected from any part of the Base: Thus, the Triangle ABC. *See* PLATE II. *Fig.* 55. is the same as ABE, each containg 100 Acres.

When the given Base is so situated that a Perpendicular of sufficient length cannot be erected therefrom, continue the Base as from B to D. *Fig.* 56. from which erect the Perpendicular DC, and complete the Triangle ABC, which will contain 100 Acres.

Find the Bearing and Distance of CI by RIGHT ANGLED TRIGONOMETRY, CASE IV. as follows:

As CK, the Southing of CI, 109 - -	2.03743
: Radius - - - - - - -	10.00000
: : KI, the Westing of CI, 71.7 - -	1.85552
	11.85552
	2.03743
: Tangent Course S. 33° 20′ W. - -	9.81809
As Sine Course 33° 20′ - - - - -	9.73997
Departure KI 71.7 - - -	1.85552
: : Radius - - - - -	10.00000
	11.85552
	9.73997
: Distance IC 130 - - -	2.11555

Note. In this way the Course and Distance may be found from one Angle of a Field to another.

Having found the Line CI divide 3470, the number of Rods to be contained in the Triangle ICN, by one half the Line CI, *viz.* 65, the Quotient will be the length of the Perpendicular PN, *viz.* 53.4.

Now, by the Bearings of CI and CD it appears that they form an Angle of 60° 20′; wherefore in the Triangle CPN are given the side PN 53.4 and the Angle at C 60° 20′, to find the Hypothenuse CN.

As Sine PCN 60° 20′	9.93898
: Side PN 53.4 -	1.72754
: : Radius - -	10.00000
	11.72754
	9.93898
: Hyp. CN 61.5	1.78856

Thus the dividing Line must go from I to a Point on the Line CD, which is 61.5 Rods from C. The Bearing and Distance of this Line may be found by the directions given above for finding the Bearing and Distance of the Line CI. Or, they may be found by Oblique Trigonometry CASE III.

Another method of finding the Distance CN.

Having ascertained the Latitude and Departure of the Line CI, set them down in a Traverse Table; find the Latitude and Departure of the Line CD, and place them in the Table; the Difference between the Northing of the Line IC and the Southing of the Line CD will be the Southing of the Line DI. *viz.* 6.6; and the Sum of the Eastings of those Lines, as they are both Easterly will be the Westing of the Line DI, *viz.* 123.9. Proceed to calculate the Area of the Triangle ICD, which will be found to be 6522 Rods, nearest.

Note. As in this Triangle two Sides and their contained Angle are given, the Area may be found by PROB. IX. *Rule* 4. *Page* 39.

Having found the Area of this Triangle, proceed to find CN according to PROB. II. *Page* 71, as follows:

As the Area of the Triangle; Is to CD the Base; So is the quantity to be contained in the Triangle ICN; To CN its proportion of the Base.

As 6522 : 115 : : 3470 : 61.2

A third method of finding the Distance CN.

To the Logarithm of double the Area to be contained within the Triangle ICN add Radius; from this Sum subtract the Logarithmic Sine of the angle at C; and from the Remainder subtract the Logarithm of the Side IC; the last Remainder will be the Logarithm of the Side CN.

The double Area of the Triangle ICN is 6940; the Angle at C is 60° 20′; the Side IC is 130.

Double Area 6940 -	3.84136
Radius - -	10.00000
	13.84136
Sine ICN 60° 20′	9.93898
	3.90238
Side IC 130 -	2.11394
Side CN 61.5 -	1.78844

Dist.	16° 0′		16° 15′		16° 30′		16° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.96	0.28	0.96	0.28	0.96	0.28	0.96	0.29	1
2	1.92	0.55	1.92	0.56	1.92	0.57	1.92	0.58	2
3	2.88	0.83	2.88	0.84	2.88	0.85	2.87	0.86	3
4	3.85	1.10	3.84	1.12	3.84	1.14	3.83	1.15	4
5	4.81	1.38	4.80	1.40	4.79	1.42	4.79	1.44	5
6	5.77	1.65	5.76	1.68	5.75	1.70	5.75	1.73	6
7	6.73	1.93	6.72	1.96	6.71	1.99	6.70	2.02	7
8	7.69	2.21	7.68	2.24	7.67	2.27	7.66	2.31	8
9	8.65	2.48	8.64	2.52	8.63	2.56	8.62	2.59	9
10	9.61	2.76	9.60	2.80	9.59	2.84	9.58	2.88	10
11	10.57	3.03	10.56	3.08	10.55	3.12	10.53	3.17	11
12	11.54	3.31	11.52	3.36	11.51	3.41	11.49	3.46	12
13	12.50	3.58	12.48	3.64	12.46	3.69	12.45	3.75	13
14	13.46	3.86	13.44	3.92	13.42	3.98	13.41	4.03	14
15	14.42	4.13	14.40	4.20	14.38	4.26	14.36	4.32	15
16	15.38	4.41	15.36	4.48	15.34	4.54	15.32	4.61	16
17	16.34	4.69	16.32	4.76	16.30	4.83	16.28	4.90	17
18	17.30	4.96	17.28	5.04	17.26	5.11	17.24	5.19	18
19	18.26	5.24	18.24	5.32	18.22	5.40	18.19	5.48	19
20	19.23	5.51	19.20	5.60	19.18	5.68	19.15	5.76	20
21	20.19	5.79	20.16	5.88	20.14	5.96	20.11	6.05	21
22	21.15	6.06	21.12	6.16	21.09	6.25	21.07	6.34	22
23	22.11	6.34	22.08	6.44	22.05	6.53	22.02	6.63	23
24	23.07	6.62	23.04	6.72	23.01	6.82	22.98	6.92	24
25	24.03	6.89	24.00	7.00	23.97	7.10	23.94	7.21	25
26	24.99	7.17	24.96	7.28	24.93	7.38	24.90	7.49	26
27	25.95	7.44	25.92	7.56	25.89	7.67	25.85	7.78	27
28	26.92	7.72	26.88	7.84	26.85	7.95	26.81	8.07	28
29	27.88	7.99	27.84	8.12	27.81	8.24	27.77	8.36	29
30	28.84	8.27	28.80	8.39	28.76	8.52	28.73	8.65	30
31	29.80	8.54	29.76	8.67	29.72	8.80	29.68	8.93	31
32	30.76	8.82	30.72	8.95	30.68	9.09	30.64	9.22	32
33	31.72	9.10	31.68	9.23	31.64	9.37	31.60	9.51	33
34	32.68	9.37	32.64	9.51	32.60	9.66	32.56	9.80	34
35	33.64	9.65	33.60	9.79	33.56	9.94	33.51	10.09	35
36	34.61	9.92	34.56	10.07	34.52	10.22	34.47	10.38	36
37	35.57	10.20	35.52	10.35	35.48	10.51	35.43	10.66	37
38	36.53	10.47	36.48	10.63	36.44	10.79	36.39	10.95	38
39	37.49	10.75	37.44	10.91	37.99	11.08	37.35	11.24	39
40	38.45	11.03	38.40	11.19	38.35	11.36	38.30	11.53	40
41	39.41	11.30	39.36	11.47	39.31	11.64	39.26	11.82	41
42	40.37	11.58	40.32	11.75	40.27	11.93	40.22	12.10	42
43	41.33	11.85	41.28	12.03	41.23	12.21	41.18	12.39	43
44	42.30	12.13	42.24	12.31	42.19	12.50	42.13	12.68	44
45	43.26	12.40	43.20	12.59	43.15	12.78	43.09	12.97	45
46	44.22	12.68	44.16	12.87	44.11	13.06	44.05	13.26	46
47	45.18	12.96	45.12	13.15	45.06	13.35	45.01	13.55	47
48	46.14	13.23	46.08	13.43	46.02	13.63	45.96	13.83	48
49	47.10	13.51	47.04	13.71	46.98	13.92	46.92	14.12	49
50	48.06	13.78	48.00	13.99	47.94	14.20	47.88	14.41	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	74° 0′		73° 45′		73° 30′		73° 15′		

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CONCLUDING REMARKS.

Other methods of surveying Fields are taught by some authors on this Subject. The preceding, however, will be found most useful in actual practice. Other instruments besides those mentioned in this Book are also sometimes used; such as the Plain Table, Semicircle, Perambulator, Theodolite, &c. But of these instruments very little use is made in New-England; and they are not often to be met with. For general practice none will be found more useful than a common Chain, and a Compass upon Rittenhouse's construction. A Surveyor should also provide himself with an Offset Staff, ten Links in length, and accurately divided into Links. This should be made of firm, hard wood, and will be found very convenient in taking Offsets, and also in measuring the Chain; which should be often done, as from a variety of causes a Chain is liable to become inaccurate.

It will be observed that in this Work there are no descriptions of Mathematical and Surveying instruments. The Compiler omitted such descriptions from a belief that nothing which can be written on the Subject will enable a person to understand them without an actual inspection of the instruments themselves, and some instruction from those acquainted with them.

The general principles here taught may be applied to the surveying of Townships, Roads, Rivers, Harbors, &c.

APPENDIX.

Of the VARIATION of the COMPASS and ATTRACTION of the NEEDLE.

THE Variation of the Compass is the number of Degrees that the Magnetic Needle points from the true North, either East or West. This differs in different places, and in the same place at different times. It is, at present, in Connecticut, a few degrees to the Westward. That is, the Needle points to the Westward of North and is gradually approaching the true North.

The following method of ascertaining the Variation, by the North Star, has been adopted by many Surveyors, as the most eligible to be practised on Land. It was communicated to the Compiler by MOSES WARREN, jun. Esq. of LYME, an experienced Surveyor, with permission to publish it.

The Star commonly called the North Star, is not directly North but revolves round the Pole in a small circle, once in 24 hours. It cannot therefore be due North but twice in that period; and that is within a very few minutes of the time when a Star, called *Alioth*, in the Constellation of Ursa Major, or the Great Bear, is directly over or under it. There is also another Star nearly in an opposite direction from the Pole, called *Gamma*, in the Constellation of Cassiopeia. When these three Stars are vertical the North Star is very near the Meridian; and when they are horizontal, it is at its greatest Elongation, that is, at its greatest distance east or West of the Pole, and on the same side as the Star in Cassiopeia. The Variation may be calculated when the Star is on the Meridian, or when at its greatest Elongation; more accurately, however, at the latter period, because its motion being then nearly vertical for some time gives the observer a better opportunity to complete his observation.*

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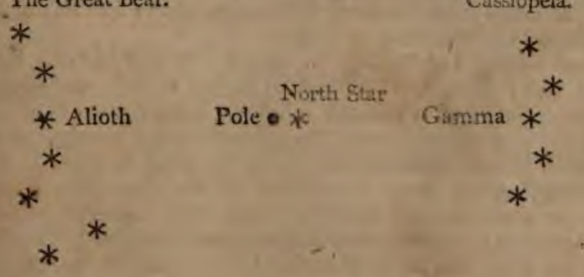
* The following Figure exhibits a view of the relative situation of these Stars as they appear, when in a horizontal position: or when the North Star is in its greatest Eastern Elongation.



To find the Elongation of this Star in any Latitude, its Declination must be known; that is, its distance North of the Equator. This being found, institute the following Proportion:

As Co-Sine of the Latitude; Is to Radius; So is Co-Sine of the Declination; to Sine of the Elongation.

From a Table in Blunt's Practical Navigator it appears that the Declination of the North Star, January 1, 1800, was 88° 14′ 32″, and increasing at the rate of 19.69 Seconds annually. Consequently, January 1, 1805, the Declination will be 88° 16′ 10″, and the Co-Declination or Polar distance will be 1° 43′ 50″.

According to the above Proportion, the Elongation, January 1, 1805, in Lat. 41° 30′ will be 2° 18″ 39″, and in Lat. 42° it will be 2° 19′ 44″.

The following Table shows the Elongation in several different Latitudes for five years successively. It is calculated for the first of January in each year; and in using it, if the time when the Elongation is required, be past the middle of the year, take it for the beginning of the next year.

A Table showing the Elongation of the North Star.

Latitud.	1805	1806	1807.	1808.	1809
39° 30′	2° 14′ 35″	2° 14′ 10″	2° 13′ 44″	2° 13′ 19″	2° 12′ 53″
40	2 15 34	2 15 8	2 14 43	2 14 17	2 13 52
40 30	2 16 34	2 16 8	2 15 42	2 15 17	2 14 51
41	2 17 36	2 17 10	2 16 44	2 16 18	2 15 52
41 30	2 18 39	2 18 13	2 17 47	2 17 20	2 16 54
42	2 19 44	2 19 18	2 18 51	2 18 25	2 17 58
42 30	2 20 51	2 20 24	2 19 58	2 19 31	2 19 5
43	2 22 0	2 21 33	2 21 6	2 20 40	2 20 13
43 30	2 23 10	2 22 43	2 22 16	2 21 49	2 21 22

The Elongation for the Latitude of the observation being calculated, or taken from the above Table, proceed to find its range, according to the following directions:

Take a pole 18 or 20 feet in length; to the end of it fasten a small line; raise it to an elevation of 45° or 50°: and support it by two crotches of a suitable height to keep it firm in its place. At the end of the line, near the ground, fasten a weight of half a pound or more, which should swing in water to prevent the air from moving the line. Southward of the line, fix a Compass sight, or other piece of metal or wood, with a narrow, perpendicular aperture at a convenient height from the ground, say about 2 or 2 1-2 feet; and let it be so fixed that it can be moved a small

Dist.	20° 0′		20° 15′		20° 30′		20° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.94	0.34	0.94	0.35	0.94	0.35	0.94	0.35	1
2	1.88	0.68	1.88	0.69	1.87	0.70	1.87	0.71	2
3	2.82	1.03	2.81	1.04	2.81	1.05	2.81	1.06	3
4	3.76	1.37	3.75	1.38	3.75	1.40	3.74	1.42	4
5	4.70	1.71	4.69	1.73	4.68	1.75	4.68	1.77	5
6	5.64	2.05	5.63	2.08	5.62	2.10	5.61	2.13	6
7	6.58	2.39	6.57	2.42	6.56	2.45	6.55	2.48	7
8	7.52	2.74	7.51	2.77	7.49	2.80	7.48	2.83	8
9	8.46	3.08	8.44	3.12	8.43	3.15	8.42	3.19	9
10	9.40	3.42	9.38	3.46	9.37	3.50	9.35	3.54	10
11	10.34	3.76	10.32	3.81	10.30	3.85	10.29	3.90	11
12	11.28	4.10	11.26	4.15	11.24	4.20	11.22	4.25	12
13	12.22	4.45	12.20	4.50	12.18	4.55	12.16	4.61	13
14	13.16	4.79	13.13	4.85	13.11	4.90	13.09	4.96	14
15	14.10	5.13	14.07	5.19	14.05	5.25	14.03	5.31	15
16	15.04	5.47	15.01	5.54	14.99	5.60	14.96	5.67	16
17	15.97	5.81	15.95	5.88	15.92	5.95	15.90	6.02	17
18	16.91	6.16	16.89	6.23	16.86	6.30	16.83	6.38	18
19	17.85	6.50	17.83	6.58	17.80	6.65	17.77	6.73	19
20	18.79	6.84	18.76	6.92	18.73	7.00	18.70	7.09	20
21	19.73	7.18	19.70	7.27	19.67	7.35	19.64	7.44	21
22	20.67	7.52	20.64	7.61	20.61	7.70	20.57	7.79	22
23	21.61	7.87	21.58	7.96	21.54	8.05	21.51	8.15	23
24	22.55	8.21	22.52	8.31	22.48	8.41	22.44	8.50	24
25	23.49	8.55	23.45	8.65	23.42	8.76	23.38	8.86	25
26	24.43	8.89	24.39	9.00	24.35	9.11	24.31	9.21	26
27	25.37	9.23	25.33	9.35	25.29	9.46	25.25	9.57	27
28	26.31	9.58	26.27	9.69	26.23	9.81	26.18	9.92	28
29	27.25	9.92	27.21	10.04	27.16	10.16	27.12	10.27	29
30	28.19	10.26	28.15	10.38	28.10	10.71	28.05	10.63	30
31	29.13	10.60	29.08	10.73	29.04	10.86	28.99	10.98	31
32	30.07	10.94	30.02	11.08	29.97	11.21	29.92	11.34	32
33	31.01	11.29	30.96	11.42	30.91	11.56	30.86	11.69	33
34	31.95	11.63	31.90	11.77	31.85	11.91	31.79	12.05	34
35	32.89	11.97	32.84	12.11	32.78	12.26	32.73	12.40	35
36	33.83	12.31	33.77	12.46	33.72	12.61	33.67	12.75	36
37	34.77	12.65	34.71	12.81	34.66	12.96	34.60	13.11	37
38	35.71	13.00	35.65	13.15	35.59	13.31	35.54	13.46	38
39	36.65	13.34	36.59	13.50	36.53	13.66	36.47	13.82	39
40	37.59	13.68	37.53	13.84	37.47	14.01	37.41	14.17	40
41	38.53	14.02	38.47	14.19	38.40	14.36	38.34	14.53	41
42	39.47	14.36	39.40	14.54	39.34	14.71	39.28	14.88	42
43	40.41	14.71	40.34	14.88	40.28	15.06	40.21	15.23	43
44	41.35	15.05	41.28	15.23	41.21	15.41	41.15	15.59	44
45	42.29	15.39	42.22	15.58	42.15	15.76	42.08	15.94	45
46	43.23	15.73	43.16	15.92	43.09	16.11	43.02	16.30	46
47	44.17	16.07	44.09	16.27	44.02	16.46	43.95	16.65	47
48	45.11	16.42	45.03	16.61	44.96	16.81	44.89	17.01	48
49	46.04	16.76	45.97	16.96	45.90	17.16	45.82	17.36	49
50	46.98	17.10	46.91	17.31	46.83	17.51	46.76	17.71	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	70° 0′		69° 45′		69° 30′		69° 15′		

A Rule to find the difference between the present Variation of the Compass, and that at a time when a Tract was formerly surveyed, in order to trace or run out the original lines.

Go to any part of the premises where any two adjacent corners are known ; and, if one can be seen from the other, take their bearing ; which, compared with that of the same line in the former survey, shows the difference. But if one corner cannot be seen from the other, run the line according to the given bearing, and observe the nearest distance between the line so run and the corner : then work by the following proportion,

As the length of the whole line,
Is to 57.3 Degrees,*
So is the said Distance,
To the difference of Variation required,

EXAMPLE.

Suppose it be required to run a line which, some years ago bore N. 45°. E. distance 20 Chains, and in running this line by the given bearing, the corner is found 20 Links to the left hand ; what is the present bearing of this line ?

	Ch.		Deg.		L.
As	20	:	57.3	: :	20
	100		20		
	2000		1146.0		
			60		

2000) 68760 (34 Minutes.

Answer 34 Minutes to the left hand is the allowance required, and the line in question bears N. 44°. 26′ E.

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* 57.3 Degrees is the Radius of a Circle (nearly) in such parts as the Circumference contains 360.

MATHEMATICAL TABLES.

VIZ.

I. *A Traverse Table, or Table of Difference of Latitude and Departure.*

II. *A Table of Natural Sines.*

III. *A Table of Logarithms for Numbers.*

IV. *A Table of Logarithmic or Artificial Sines, Tangents and Secants.*

◆

I. A Traverse Table, or Table of Difference of Latitude and Departure, calculated for Degrees and Quarters of Degrees, and for any Distance up to 50 Rods, Chains, &c; by which the Northings and Southings, Eastings and Westings made in a Survey may be found.

Note. Northings and Southings are called Difference of Latitude, or simply Latitude; Eastings and Westings are called Departure, Meridian Distance, or Longitude.

Explanation of the Table.

To find the Latitude and Departure, or Northing, &c. for any Course and Distance.

If the Course be less than 45°, look for it at the Top, but if more than 45°, at the Bottom of the Page; and look for the Distance in the Right or Left hand Column: Against the Distance, and directly under or over the Course, stand the Northing, &c. in whole Numbers and Decimals.

If the Course be less than 45°, the Northing or Southing will be greater than the Easting or Westing; but if more than 45°, the Easting or Westing will be the greatest.

When the Distance exceeds 50, divide it by 2, 3, or 4, that is, take one half, one third, or one fourth of it, and multiply the Latitude and Departure by the number by which the Distance was divided: Or, take any two or more numbers which added together will equal the Distance, and find the Latitude and Departure for each of those numbers; add the several Latitudes together and the sum will be the whole Latitude; and so for the Departure. And when the Distance is in Chains and Links, or whole Numbers and Decimals, find the Latitude, &c. for the Chains or whole Numbers, and then for the Links or Decimals, remembering to remove the Decimal Point in the Table further to the Left, according to the given Decimal.

EXAMPLES.

1. *Required the Latitude and Departure for* 45 *Rods, on a Course N.* 15° 15′ *W.*

Under 15° 15′ and against 45 is 43.42 for the Northing and 11.84 for the Westing.

2. *Required the Latitude and Departure for* 120 *Rods; on a Course S.* 58° 30′ *E.*

Take one third of 120 which is 40; against this number, over 58° 30′ is 20.90 for the Latitude and 34.11 for the Departure. These multiplied by 3 give 62.70 for the Southing and 102.33 for the Easting.

3. *Required the Latitude and Departure for* 37.36 *Rods or* 37 *Chains and* 36 *Links, on a Course N.* 26° 45′ *E.*

For	37.	Lat.	33.04	Dep.	16.65
	0.36		.32		.16
	37.36		33.36		16.81

Northing 33.36 Easting 16.81

Note. When the Minutes are not 15, 30 or 45, the Northings, &c. must be calculated by Natural Sines, or by Trigonometry.

Note in the second Edition. The Traverse Table, as published in the first Edition of this work was copied from a Table in Gibson. The Compiler, finding that to be incorrect in several places, has calculated the whole anew; and it is presumed it will be found to be correct as published in this Edition.

Dist.	0° 15′		0° 30′		0° 45′		Dist.
	Lat.	Dep	Lat.	Dep	Lat.	Dep.	
1	1.00	0.00	1.00	0.01	1.00	0.01	1
2	2.00	0.01	2.00	0.02	2.00	0.03	2
3	3.00	0.01	3.00	0.03	3.00	0.04	3
4	4.00	0.02	4.00	0.03	4.00	0.05	4
5	5.00	0.02	5.00	0.04	5.00	0.07	5
6	6.00	0.03	6.00	0.05	6.00	0.08	6
7	7.00	0.03	7.00	0.06	7.00	0.09	7
8	8.00	0.03	8.00	0.07	8.00	0.10	8
9	9.00	0.04	9.00	0.08	9.00	0.12	9
10	10.00	0.04	10 00	0.09	10.00	0.13	10
11	11.00	0.05	11.00	0.10	11.00	0.14	11
12	12.00	0.05	12.00	0.10	12.00	0.16	12
13	13.00	0.06	13.00	0.11	13.00	0.17	13
14	14.00	0.06	14.00	0.12	14.00	0.18	14
15	15.00	0.07	15.00	0.13	15.00	0.20	15
16	16.00	0.07	16.00	0·14	16.00	0.21	16
17	17.00	0.07	17.00	0.15	17.00	0.22	17
18	18.00	0.08	18.00	0.16	18.00	0.24	18
19	19.00	0.08	19.00	0.17	19.00	0.25	19
20	20.00	0 09	20.00	0.17	20.00	0.26	20
21	21.00	0.09	21.00	0.18	21.00	0.27	21
22	22.00	0.10	22.00	0.19	22.00	0.29	22
23	23.00	0.10	23.00	0.20	23.00	0.30	23
24	24.00	0.10	24.00	0.21	24.00	0.31	24
25	25.00	0.11	25.00	0.22	25.00	0.33	25
26	26.00	0.11	26·00	0.23	26.00	0.34	26
27	27.00	0.12	27.00	0.24	27.00	0.35	27
28	28.00	0.12	28.00	0.24	28.00	0.37	28
29	29.00	0.13	29.00	0.25	29.00	0.38	39
30	30.00	0.13	30.00	0.26	30.00	0.39	30
31	31.00	0.14	31.00	0.27	31.00	0.41	31
32	32.00	0.14	32.00	0.28	32.00	0.42	32
33	33.00	0.14	33.00	0.29	33.00	0.43	33
34	34.00	0.15	34.00	0.30	34.00	0.45	34
35	35.00	0.15	35.00	0.31	35.00	0.46	35
36	36.00	0.16	36.00	0.31	36.00	0.47	36
37	37.00	0.16	37.00	0.32	37.00	0.48	37
38	38.00	0.17	38.00	0.33	38.00	0.50	38
39	39.00	0.17	39.00	0.34	39.00	0.51	39
40	40.00	0.17	40.00	0.35	40.00	0.52	40
41	41.00	0.18	41.00	0.36	41.00	0.54	41
42	42.00	0.18	42.00	0.37	42.00	0.55	42
43	43.00	0·19	43.00	0.38	43.00	0.56	43
44	44.00	0.19	44.00	0.38	44.00	0.58	44
45	45.00	0.20	45.00	0.39	45.00	0.59	45
46	46.00	0.20	46.00	0.40	46.00	0.60	46
47	47.00	0.20	47 00	0.41	47.00	0.62	47
48	48.00	0.21	48 00	0.42	48.00	0.63	48
49	49.00	0.21	49.00	0.43	49.00	0.64	49
50	50.00	0.22	40.00	0.44	50.00	0.65	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	89° 45′		89° 30′		89° 15′		

Dist.	25° 0′		25° 15′		25° 30°		25° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.91	0.42	0.90	0.43	0.90	0.43	0.90	0.43	1
2	1.81	0.85	1.81	0.85	1.81	0.86	1.80	0.87	2
3	2.72	1.27	2.71	1.28	2.71	1.29	2.70	1.30	3
4	3.63	1.69	3.62	1.71	3.61	1.72	3.60	1.74	4
5	4.53	2.11	4.52	2.13	4.51	2.15	4.50	2.17	5
6	5.44	2.54	5.43	2.56	5.42	2.58	5.40	2.61	6
7	6.34	2.96	6.33	2.99	6.32	3.01	6.30	3.04	7
8	7.25	3.38	7.24	3.41	7 22	3.44	7.21	3.48	8
9	8.16	3.80	8.14	3.84	8.12	3.87	8.11	3.91	9
10	9.06	4.23	9.04	4.27	9.03	4.31	9.01	4.34	10
11	9.97	4.65	9.95	4.69	9.93	4.74	9.91	4.78	11
12	10.88	5.07	10.85	5.12	10.83	5.17	10.81	5.21	12
13	11.78	5.49	11.76	5.55	11.73	5.60	11.71	5.65	13
14	12.69	5.92	12.66	5.97	12.64	6.03	12.61	6.08	14
15	13.59	6.34	13.57	6.40	13.54	6.46	13.51	6.52	15
16	14.50	6.76	14.47	6.83	14.44	6.89	14.41	6.95	16
17	15.41	7.18	15.38	7.25	15.34	7.32	15.31	7.39	17
18	16.31	7.61	16.28	7.68	16.25	7.75	16.21	7.82	18
19	17.22	8.03	17.18	8.10	17.15	8.18	17.11	8.25	19
20	18.13	8.45	18.09	8.53	18.05	8.61	18.01	8.69	20
21	19.03	8.88	18.99	8.96	18.95	9.04	18.91	9.12	21
22	19.94	9.30	19.90	9.38	19.86	9.47	19.82	9.56	22
23	20.85	9.72	20.80	9.81	20.76	9.90	20.72	9.99	23
24	21.75	10.14	21.71	10.24	21.66	10.33	21.62	10.43	24
25	22.66	10.57	22.61	10.66	22.56	10.76	22.52	10.86	25
26	23.56	10.99	23.52	11.09	23.47	11.19	23.42	11.30	26
27	24.47	11.41	24.42	11.52	24.37	11.62	24.32	11.73	27
28	25.38	11.83	25.32	11.94	25.27	12.05	25.22	12.16	28
29	26.28	12.26	26.23	12.37	26.18	12.48	26.12	12.60	29
30	27.19	12.68	27.13	12.80	27.08	12.92	27.02	13.03	30
31	28.10	13.10	28.04	13.22	27.98	13.35	27.92	13.47	31
32	29.00	13.52	28.94	13.65	28.88	13.78	28.82	13.90	32
33	29.91	13.95	29.85	14.08	29.79	14.21	29.72	14.34	33
34	30.81	14.37	30.75	14.50	30.69	14.64	30.62	14.77	34
35	31.72	14.79	31.66	14.93	31.59	15.07	31.52	15.21	35
36	32.63	15.21	32.56	15.36	32.49	15.50	32.43	15.64	36
37	33.53	15.64	33.47	15.78	33.40	15.93	33.33	16.07	37
38	34.44	16.06	34.37	16.21	34.30	16.36	34.23	16.51	38
39	35.35	16.48	35.27	16.64	35.20	16.79	35.13	16.94	39
40	36.25	16.90	36.18	17.06	36.10	17.22	36.03	17.38	40
41	37.16	17.33	37.08	17.49	37.01	17.65	36.93	17.81	41
42	38.07	17.76	37.99	17.92	37.91	18.08	37.83	18.25	42
43	38.97	18.17	38.89	18.34	38.81	18.51	38.73	18.68	43
44	39.88	18.60	39.80	18.77	39.71	18.94	39.63	19.12	44
45	40.78	19.02	40.70	19.20	40.62	19.37	40.53	19.55	45
46	41.69	19.44	41.61	19.62	41.52	19.80	41.43	19.98	46
47	42.60	19.86	42.51	20.05	42.42	20.23	42.33	20.42	47
48	43.50	20.29	43.41	20.48	43.32	20.66	43.23	20.85	48
49	44.41	20.71	44.32	20.90	44.23	21.09	44.13	21.29	49
50	45.32	21.13	45.22	21.33	45.13	21.53	45.03	21.72	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Dep.	Dist.
	65° 0′		64° 45′		64° 30′		64° 15′		

Dist.	4° 0'		4° 15'		4° 30'		4° 45'		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	1.00	0.07	1.00	0.07	1.00	0.08	1.00	0.08	1
2	2.00	0.14	1.99	0.15	1.99	0.16	1.99	0.17	2
3	2.99	0.21	2.99	0.22	2.99	0.24	2.99	0.25	3
4	3.99	0.28	3.99	0.30	3.99	0.31	3.99	0.33	4
5	4.99	0.35	4.99	0.37	4.98	0.39	4.98	0.41	5
6	5.99	0.42	5.98	0.44	5.98	0.47	5.98	0.50	6
7	6.98	0.49	6.98	0.52	6.98	0.55	6.98	0.58	7
8	7.98	0.56	7.98	0.59	7.98	0.63	7.97	0.66	8
9	8.98	0.63	8.98	0.67	8.97	0.71	8.97	0.75	9
10	9.98	0.70	9.97	0.74	9.97	0.78	9.97	0.83	10
11	10.97	0.77	10.97	0.82	10.97	0.86	10.96	0.91	11
12	11.97	0.84	11.97	0.89	11.96	0.94	11.96	0.99	12
13	12.97	0.91	12.96	0.96	12.96	1.02	12.96	1.08	13
14	13.97	0.98	13.96	1.04	13.96	1.10	13.95	1.16	14
15	14.96	1.05	14.96	1.11	14.95	1.18	14.95	1.24	15
16	15.96	1.12	15.96	1.19	15.95	1.26	15.94	1.33	16
17	16.96	1.19	16.95	1.26	16.95	1.33	16.94	1.41	17
18	17.96	1.26	17.95	1.33	17.94	1.41	17.94	1.49	18
19	18.95	1.33	18.95	1.41	18.94	1.49	18.93	1.57	19
20	19.95	1.40	19.95	1.48	19.94	1.57	19.93	1.66	20
21	20.95	1.47	20.94	1.56	20.94	1.65	20.93	1.74	21
22	21.95	1.53	21.94	1.63	21.93	1.73	21.92	1.82	22
23	22.94	1.60	22.94	1.70	22.93	1.80	22.92	1.90	23
24	23.94	1.67	23.93	1.78	23.93	1.88	23.92	1.99	24
25	24.94	1.74	24.93	1.85	24.92	1.96	24.91	2.07	25
26	25.94	1.81	25.93	1.93	25.92	2.04	25.91	2.15	26
27	26.93	1.88	26.93	2.00	26.92	2.12	26.91	2.24	27
28	27.93	1.95	27.92	2.08	27.91	2.20	27.90	2.32	28
29	28.93	2.02	28.92	2.15	28.91	2.28	28.90	2.40	29
30	29.93	2.09	29.92	2.22	29.91	2.35	29.90	2.48	30
31	30.92	2.16	30.91	2.30	30.90	2.43	30.89	2.57	31
32	31.92	2.23	31.91	2.37	31.90	2.51	31.89	2.65	32
33	32.92	2.30	32.91	2.45	32.90	2.59	32.89	2.73	33
34	33.92	2.37	33.91	2.52	33.90	2.67	33.88	2.82	34
35	34.91	2.44	34.90	2.59	34.89	2.75	34.88	2.90	35
36	35.91	2.51	35.90	2.67	35.89	2.82	35.88	2.98	36
37	36.91	2.58	36.90	2.74	36.89	2.90	36.87	3.06	37
38	37.91	2.65	37.90	2.82	37.88	2.98	37.87	3.15	38
39	38.90	2.72	38.89	2.89	38.88	3.06	38.87	3.23	39
40	39.90	2.79	39.89	2.96	39.88	3.14	39.86	3.31	40
41	40.90	2,86	40.89	3.04	40.87	3.22	40.86	3.40	41
42	41.90	2.93	41.88	3.11	41.87	3.30	41.86	3.48	42
43	42.90	3.00	42.88	3.19	42.87	3.37	42.85	3.56	43
44	43.89	3.07	43.88	3.26	43.86	3.45	43.85	3.64	44
45	44.89	3.14	44.88	3.34	44.86	3.53	44.85	3.73	45
46	45.89	3.21	45.87	3.41	45.86	3.61	45.84	3.81	46
47	46.89	3.28	46.87	3.48	46.86	3.69	46.84	3.89	47
48	47.88	3.35	47.87	3.56	47.85	3.77	47.84	3.97	48
49	48.88	3.42	48.87	3.63	48.85	3.84	48.83	4.06	49
50	49.88	3.49	49.86	3.71	49.85	3.92	49.83	4.14	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	86° 0'		85° 45'		85° 30'		85° 15'		

Dist.	27° 0′		27° 15′		27° 30′		27° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.89	0.45	0.89	0.46	0.89	0.46	0.88	0.47	1
2	1.78	0.91	1.78	0.92	1.77	0.92	1.77	0.93	2
3	2.67	1.36	2.67	1.37	2.66	1.39	2.65	1.40	3
4	3.56	1.82	3.56	1.83	3.55	1.85	3.54	1.86	4
5	4.46	2.27	4.45	2.29	4.44	2.31	4.42	2.33	5
6	5.35	2.72	5.33	2.75	5.32	2.77	5.31	2.79	6
7	6.24	3.18	6.22	3.21	6.21	3.23	6.19	3.26	7
8	7.13	3.63	7.11	3.66	7.10	3.69	7.08	3.72	8
9	8.02	4.09	8.00	4.12	7.98	4.16	7.96	4.19	9
10	8.91	4.54	8.89	4.58	8.87	4.62	8.85	4.66	10
11	9.80	4.99	9.78	5.04	9.76	5.08	9.73	5.12	11
12	10.69	5.45	10.67	5.49	10.64	5.54	10.62	5.59	12
13	11.58	5.90	11.56	5.95	11.53	6.00	11.50	6.05	13
14	12.47	6·36	12.45	6.41	12 42	6.46	12.39	6.52	14
15	13.37	6.81	13.34	6.87	13.31	6.93	13.27	6.98	15
16	14.26	7.26	14.22	7.33	14.19	7.39	14.16	7.45	16
17	15.15	7.72	15.11	7.78	15.08	7.85	15.04	7.92	17
18	16.04	8.17	16.00	8.24	15·97	8.31	15.93	8.38	18
19	16.93	8.63	16.89	8.70	16.85	8.77	16.81	8.85	19
20	17.82	9.08	17.78	9.16	17.74	9.23	17.70	9.31	20
21	18.71	9.53	18.67	9.62	18.63	9.70	18.58	9.78	21
22	19.60	9.99	19.56	10.07	19.51	10.16	19.47	10.24	22
23	20.49	10.44	20.45	10.53	20.40	10.62	20.35	10.71	23
24	21.38	10.90	21.34	10.99	21.29	11.08	21.24	11.17	24
25	22.28	11.35	22.23	11.45	22.18	11.54	22.12	11.64	25
26	23.17	11.80	23.11	11.90	23.06	12.01	33.01	12.11	26
27	24.06	12.26	24.00	12.36	23.95	12.47	23.89	12.57	27
28	24.95	12.71	24.89	12.82	24.84	12.93	24.78	13.04	28
29	25.84	13.17	25.78	13.28	25.72	13.39	25.66	13.50	29
30	26.73	13.62	26.67	13.74	26.61	13.85	26.55	13.97	30
31	27.62	14.07	27.56	14.19	27.50	14.31	27.43	14.43	31
32	28.51	14.53	28.45	14.65	28.38	14.78	28.32	14.90	32
33	29.40	14.98	29.34	15.11	29.27	15.24	29.20	15.37	33
34	30.29	15.44	30.23	15.57	30.16	15.70	30.09	15.83	34
35	31.19	15.89	31.12	16.03	31.05	16.16	30.97	16.30	35
36	32.08	16.34	32.00	16.48	31.93	16.62	31.86	16.76	36
37	32.97	16.80	32.89	16.94	32.82	17.08	32.74	17.23	37
38	33.86	17.25	33.78	17 40	33.71	17.55	33.63	17.69	38
39	34.75	17.71	34.67	17.86	34.59	18.01	34.51	18.16	39
40	35.64	18.16	35.56	18.31	35.48	18.47	35.40	18.62	40
41	36.53	18.61	36.45	18.77	36.37	18.93	36.28	19.09	41
42	37.42	19.07	37.34	19.23	37.25	19.39	37.17	19.56	42
43	38.31	19.52	38.23	19.69	38.14	19.86	38.05	20.02	43
44	39.20	19.98	39.12	20.15	39.03	20.32	38.94	20.49	44
45	40.10	20.43	40.01	20.60	39.92	20.78	39.82	20.95	45
46	40.99	20.88	40.89	21.06	40.80	21.24	40.71	21.42	46
47	41.88	21.34	41.78	21.52	41.69	21.70	41.59	21.88	47
48	42.77	21.79	42.67	21.98	42.58	22.16	42.48	22.35	48
49	43.66	22.25	43.56	22.44	43.46	22.63	43.36	22.81	49
50	44.55	22.70	44 45	22.89	44.35	23.09	44.25	23.28	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	63° 0′		62° 45′		62° 30′		62° 15′		

Dist.	28° 0′		28° 15′		28° 30′		28° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.88	0.47	0.88	0.47	0.88	0.48	0.88	0.48	1
2	1.77	0.94	1.76	0.95	1.76	0.95	1.75	0.96	2
3	2.65	1.41	2.64	1.42	2.64	1.43	2.63	1.44	3
4	3.53	1.88	3.52	1.89	3.52	1.91	3.51	1.92	4
5	4.41	2.35	4.40	2.37	4.39	2.39	4.38	2.40	5
6	5.30	2.82	5.29	2.84	5.27	2.86	5.26	2.89	6
7	6.18	3.29	6.17	3.31	6.15	3.34	6.14	3.37	7
8	7.06	3.76	7.05	3.79	7.03	3.82	7.01	3.85	8
9	7.95	4.23	7.93	4.26	7.91	4.29	7.89	4.33	9
10	8.83	4.69	8.81	4.73	8.79	4.77	8.77	4.81	10
11	9.71	5.16	9.69	5.21	9.67	5.25	9.64	5.29	11
12	10.60	5.63	10.57	5.68	10.55	5.73	10.52	5.77	12
13	11.48	6.10	11.45	6.15	11.42	6.20	11.40	6.25	13
14	12.36	6.57	12.33	6.63	12.30	6.68	12.27	6.73	14
15	13.24	7.04	13.21	7.10	13.18	7.16	13.15	7.21	15
16	14.13	7.51	14.09	7.57	14.06	7.63	14.03	7.70	16
17	15.01	7.98	14.98	8.05	14.94	8.11	14.90	8.18	17
18	15.89	8.45	15.86	8.52	15.82	8.59	15.78	8.66	18
19	16.78	8.92	16.74	8.99	16.70	9.07	16.66	9.14	19
20	17.66	9.39	17.62	9.47	17.58	9.54	17.53	9.62	20
21	18.54	9.86	18.50	9.94	18.46	10.02	18.41	10.10	21
22	19.42	10.33	19.38	10.41	19.33	10.50	19.29	10.58	22
23	20.31	10.80	20.26	10.89	20.21	10.97	20.16	11.06	23
24	21.19	11.27	21.14	11.36	21.09	11.45	21.04	11.54	24
25	22.07	11.74	22.02	11.83	21.97	11.93	21.92	12.02	25
26	22.96	12.21	22.90	12.31	22.85	12.41	22.79	12.51	26
27	23.84	12.68	23.78	12.78	23.73	12.88	23.67	12.99	27
28	24.72	13.15	24.66	13.25	24.61	13.36	24.55	13.47	28
29	25.61	13.61	25.55	13.73	25.49	13.84	25.43	13.95	29
30	26.49	14.08	26.43	14.20	26.36	14.31	26.30	14.43	30
31	27.37	14.55	27.31	14.67	27.24	14.79	27.18	14.91	31
32	28.25	15.02	28.19	15.15	28.12	15.27	28.06	15.39	32
33	29.14	15.49	29.07	15.62	29.00	15.75	28.93	15.87	33
34	30.02	15.96	29.95	16.09	29.88	16.22	29.81	16.35	34
35	30.90	16.43	30.83	16.57	30.76	16.70	30.69	16.83	35
36	31.79	16.90	31.71	17.04	31.64	17.18	31.56	17.32	36
37	32.67	17.37	32.59	17.51	32.52	17.65	32.44	17.80	37
38	33.55	17.84	33.47	17.99	33.40	18.13	33.32	18.28	38
39	34.44	18.31	34.35	18.46	34.27	18.61	34.19	18.76	39
40	35.32	18.78	35.24	18.93	35.15	19.09	35.07	19.24	40
41	36.20	19.25	36.12	19.41	36.03	19.56	35.95	19.72	41
42	37.08	19.72	37.00	19.88	36.91	20.04	36.82	20.20	42
43	37.97	20.19	37.88	20.35	37.79	20.52	37.70	20.68	43
44	38.85	20.66	38.76	20.83	38.67	21.00	38.58	21.16	44
45	39.73	21.13	39.64	21·30	39.55	21.47	39.45	21.64	45
46	40.62	21.60	40.52	21.77	40.43	21.95	40.33	22.13	46
47	41.50	22.07	41.40	22.25	41.30	22.43	41.21	22.61	47
48	42.38	22.53	42.28	22.72	42.18	22.90	42.08	23.09	48
49	43.26	23.00	43.16	23.19	43.06	23.38	42.96	23.57	49
50	44.15	23.47	44.04	23.67	43.94	23.86	43.84	24.05	50
Dist.	Dep.	Lat.	Dep.	Lat	Dep.	Lat.	Dep.	Lat.	Dist.
	62° 0′		61° 45′		61° 30′		61° 15′		

Dist.	29° 0′		29° 15′		29° 30′		29° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.87	0.48	0.87	0.49	0.87	0.49	0.87	0.50	1
2	1.75	0.97	1.75	0.98	1.74	0.98	1.74	0.99	2
3	2.62	1.45	2.62	1.47	2.61	1.48	2.60	1.49	3
4	3.50	1.94	3.49	1.95	3.48	1.97	3.47	1.98	4
5	4.37	2.42	4.36	2.44	4.35	2.46	4.34	2.48	5
6	5.25	2.91	5.24	2.93	5.22	2.95	5.21	2.98	6
7	6.12	3.39	6.11	3.42	6.09	3.45	6.08	3.47	7
8	7.00	3.88	6.98	3.91	6.96	3.94	6.95	3.97	8
9	7.87	4.36	7.85	4.40	7.83	4.43	7.81	4.47	9
10	8.75	4.85	8.73	4.89	8.70	4.92	8.68	4.96	10
11	9.62	5.33	9.60	5.37	9.57	5.42	9.55	5.46	11
12	10.50	5.82	10.47	5.86	10.44	5.91	10.42	5.95	12
13	11.37	6.30	11.34	6.35	11.31	6.40	11.29	6.45	13
14	12.24	6.79	12.22	6.84	12.19	6.89	12.15	6.95	14
15	13.12	7.27	13.09	7.33	13.06	7.39	13.02	7.44	15
16	13.99	7.76	13.96	7.82	13.93	7.88	13.89	7.94	16
17	14.87	8.24	14.83	8.31	14.80	8.37	14.76	8.44	17
18	15.74	8.73	15.71	8.80	15.67	8.86	15.63	8.93	18
19	16.62	9.21	16.58	9.28	16.54	9.36	16.50	9.43	19
20	17.49	9.70	17.45	9.77	17.41	9.85	17.36	9.92	20
21	18.37	10.18	18.32	10.26	18.28	10.34	18.23	10.42	21
22	19.24	10.67	19.20	10.75	19.15	10.83	19.10	10.92	22
23	20.12	11.15	20.07	11.24	20.02	11.33	19.97	11.41	23
24	20.99	11.64	20.94	11.73	20.89	11.82	20.84	11.91	24
25	21.87	12.12	21.81	12.22	21.76	12.31	21.70	12.41	25
26	22.74	12.61	22.69	12.70	22.63	12.80	22.57	12.90	26
27	23.61	13.09	23.56	13.19	23.50	13.30	23.44	13.40	27
28	24.49	13.57	24.43	13.68	24.37	13.79	24.31	13.89	28
29	25.36	14.06	25.30	14.17	25.24	14.28	25.18	14.39	29
30	26.24	14.54	26.18	14.66	26.11	14.77	26.05	14.89	30
31	27.11	15.03	27.05	15.15	26.98	15.27	26.91	15.38	31
32	27.99	15.51	27.92	15.64	27.85	15.76	27.78	15.88	32
33	28.86	16.00	28.79	16.12	28.72	16.25	28.65	16.38	33
34	29.74	16.48	29.67	16.61	29.59	16.74	29.52	16.87	34
35	30.61	16.97	30.54	17.10	30.46	17.23	30.39	17.37	35
36	31.49	17.45	31.41	17.59	31.33	17.73	31.26	17.86	36
37	32.36	17.94	32.28	18.08	32.20	18.22	32.12	18.36	37
38	33.24	18.42	33.16	18.57	33.07	18.71	32.99	18.86	38
39	34.11	18.91	34.03	19.06	33.94	19.20	33.86	19.35	39
40	34.98	19.39	34.90	19.54	34.81	19.70	34.73	19.85	40
41	35.86	19.88	35.77	20.03	35.68	20.19	35.60	20.35	41
42	36.73	20.36	36.65	20.52	36.56	20.68	36.46	20.84	42
43	37.61	20.85	37.52	21.01	37.43	21.17	37.33	21.34	43
44	38.48	21.33	38.39	21.50	38.30	21.67	38.20	21.83	44
45	39.36	21.82	39.26	21.99	39.17	22.16	39.07	22.33	45
46	40.23	22.30	40.14	22.48	40.04	22.65	39.94	22.83	46
47	41.11	22.79	41.01	22.97	40.91	23.14	40.81	23.32	47
48	41.98	23.27	41.88	23.45	41.78	23.64	41.67	23.82	48
49	42.86	23.76	42.75	23.94	42.65	24.13	42.54	24.31	49
50	43.73	24.24	43.63	24.43	43.52	24.62	43.41	24.81	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	61° 0′		60° 45′		60° 30′		60° 15′		

Dist.	30° 0'		30° 15'		30° 30'		30° 45'		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.87	0.50	0.86	0.50	0.86	0.51	0.86	0.51	1
2	1.73	1.00	1.73	1.01	1.72	1.02	1.72	1.02	2
3	2.60	1.50	2.59	1.51	2.58	1.52	2·58	1.53	3
4	3.46	2.00	3.46	2.02	3.45	2.03	3.44	2.05	4
5	4.33	2.50	4.32	2.52	4.31	2.54	4.30	2.56	5
6	5.20	3.00	5.18	3.02	5.17	3.05	5.16	3.07	6
7	6.06	3.50	6.05	3.53	6.03	3.55	6.02	3.58	7
8	6.93	4.00	6.91	4.03	6.89	4.06	6.88	4.09	8
9	7 79	4.50	7.77	4.53	7.75	4.57	7.73	4.60	9
10	8.66	5.00	8.64	5.04	8.62	5.08	8.59	5.11	10
11	9.53	5.50	9.50	5.54	9.48	5.58	9.45	5.62	11
12	10.39	6.00	10.37	6.05	10.34	6.09	10.31	6.14	12
13	11.26	6.50	11.23	6.55	11.20	6.60	11.17	6.65	13
14	12.12	7.00	12.09	7.05	12.06	7.11	12.03	7.16	14
15	12.99	7.50	12.96	7.56	12.92	7.61	12.89	7.67	15
16	13.86	8.00	13.82	8.06	13.79	8.12	13.75	8.18	16
17	14.72	8.50	14.69	8.56	14.65	8.63	14.61	8.69	17
18	15.59	9.00	15.55	9.07	15.51	9.14	15.47	9.20	18
19	16.45	9.50	16.41	9.57	16.37	9.64	16.33	9.71	19
20	17.32	10.00	17.28	10.08	17.23	10.15	17.19	10.23	20
21	18.19	10.50	18.14	10.58	18.09	10.66	18.05	10.74	21
22	19.05	11.00	19.00	11.08	18.96	11.17	18.91	11.25	22
23	19.92	11.50	19.87	11.59	19.82	11.67	19.77	11.76	23
24	20.78	12.00	20.73	12.09	20.68	12.18	20.63	12.27	24
25	21.65	12.50	21.60	12.59	21.54	12.69	21.49	12.78	25
26	22.52	13.00	22.46	13.10	22.40	13.20	22.34	13.29	26
27	23.38	13.50	23.32	13.60	23.26	13.70	23.20	13.80	27
28	24.25	14.00	24.19	14.11	24.13	14.21	24.06	14.32	28
29	25.11	14.50	25.05	14.61	24.99	14.72	24.92	14.83	29
30	25.98	15.00	25.92	15.11	25.85	15.23	25.78	15.34	30
31	26.85	15.50	26.78	15.62	26.71	15.73	26.64	15.85	31
32	27.71	16.00	27.64	16.12	27.57	16.24	27.50	16.36	32
33	28.58	16.50	28.51	16.62	28.43	16.75	28.36	16.87	33
34	29.45	17.00	29.37	17.13	29.30	17.26	29.22	17.38	34
35	30.31	17.50	30.23	17.63	30.16	17.76	30.08	17.90	35
36	31.18	18.00	31.10	18.14	31.02	18.27	30.94	18.41	36
37	32.04	18.50	31.96	18.64	31.88	18.78	31.80	18.92	37
38	32.91	19.00	32.83	19.14	32.74	19.29	32.66	19.43	38
39	33.78	19.50	33.69	19.65	33.60	19.79	33.52	19.94	39
40	34.64	20.00	34.55	20.15	34.47	20.30	34.38	20.45	40
41	35.51	20.50	35.42	20.65	35.33	20·81	35.24	20.96	41
42	36.37	21.00	36.28	21.16	36.19	21.32	36.10	21.47	42
43	37.24	21.50	37.15	21.66	37.05	21.82	36.95	21.99	43
44	38.11	22.00	38.01	22.17	37.91	22.33	37.81	22.50	44
45	38.97	22.50	38.87	22.67	38.77	22.84	38.67	23.01	45
46	39.84	23.00	39.74	23.17	39.64	23.35	39.53	23.52	46
47	40.70	23.50	40.60	23.68	40.50	23.85	40.39	24.03	47
48	41.57	24.00	41.46	24.18	41.36	24.36	41.25	24.54	48
49	42.44	24.50	42.33	24.68	42.22	24.87	42.11	25.05	49
50	43.30	25.00	43.19	25.19	43.08	25.38	42.97	25.56	50
Dist.	Dep	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	60° 0'		59° 45'		59° 30'		59° 15'		

Dist	31° 0′		31° 15′		31° 30′		31° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.86	0.52	0.85	0.52	0.85	0.52	0.85	0.53	
2	1.71	1.03	1.71	1.04	1.71	1.04	1.70	1.05	I
3	2.57	1.55	2.56	1.56	2.56	1.57	2.55	1.58	3
4	3.43	2.06	3.42	2.08	3.41	2.09	3.40	2.10	4
5	4.29	2.58	4.27	2.59	4.26	2.61	4.25	2.63	5
6	5.14	3.09	5.13	3.11	5.12	3.13	5.10	3.16	6
7	6.00	3.61	5.98	3.63	5.97	3.66	5.95	3.68	7
8	6.86	4.12	6.84	4.15	6·82	4.18	6.80	4.21	8
9	7.71	4.64	7.69	4.67	7.67	4.70	7.65	4.74	9
10	8.57	5.15	8.55	5.19	8.53	5.22	8.50	5.26	10
11	9.43	5.67	9.40	5.71	9.38	5.75	9.35	5.79	11
12	10.29	6.18	10.26	6.23	10.23	6.27	10.20	6.31	12
13	11.14	6.70	11.11	6.74	11.08	6.79	11.05	6.84	13
14	12.00	7.21	11.97	7.26	11.94	7.32	11.90	7.37	14
15	12.86	7.73	12.82	7.78	12.79	7.84	12.76	7.89	15
16	13.71	8.24	13.68	8.30	13.64	8.36	13.61	8.42	16
17	14.57	8.76	14.53	8.82	14.49	8.88	14.46	8.95	17
18	15.43	9.27	15.39	9.34	15.35	9.40	15.31	9.47	18
19	16·29	9.79	16.24	9.86	16.20	9.93	16.16	10.00	19
20	17.14	10.30	17.10	10.38	17.05	10.45	17.01	10.52	20
21	18.00	10.82	17.95	10.89	17.91	10.97	17.86	11.05	21
22	18.86	11.33	18.81	11.41	18.76	11.50	18.71	11.58	22
23	19.71	11.85	19.66	11.93	19.61	12.02	19.56	12.10	23
24	20.57	12.36	20.52	12.45	20.46	12.54	20.41	12.63	24
25	21.43	12.88	21.37	12.97	21.32	13.06	21.26	13.16	25
26	22.29	13.39	22.23	13.49	22.17	13.59	22.11	13.68	26
27	23.14	13.91	23.08	14.01	23.02	14.11	22.96	14.21	27
28	24.00	14.42	23.94	14.53	23.87	14.63	23.81	14.73	28
29	24.86	14.94	24.79	15.04	24.73	15.16	24.66	15.26	29
30	25.72	15.45	25.65	15.56	25.58	15.68	25.51	15.79	30
31	26.57	15.97	26.50	16.08	26.43	16.20	26.36	16.31	31
32	27.43	16.48	27.36	16.60	27.28	16.72	27.21	16.84	32
33	28.29	17.00	28.21	17.12	28.14	17.24	28.06	17.36	33
34	29.14	17.51	29.07	17.64	28.99	17.77	28.91	17.89	34
35	30.00	18.03	29.92	18.16	29.84	18.29	29.76	18.42	35
36	30·86	18.54	30.78	18.68	30.70	18.81	30.61	18.94	36
37	31·72	19.06	31.63	19.19	31.55	19.33	31.46	19.47	37
38	32·57	19.57	32.49	19.71	32.40	19.86	32.31	20.00	38
39	33·43	20.09	33.34	20.23	33.25	20.38	33.16	20.52	39
40	34.29	20.60	34.20	20.75	34.11	20.90	34.01	21.05	40
41	35.14	21.12	35.05	21.27	34.96	21.42	34.86	21.57	41
42	36·00	21.63	35.91	21.79	35.81	21.95	35.71	22.10	42
43	36·86	22.15	36.76	22.31	36.66	22.47	36.57	22.63	43
44	37·72	22.66	37.62	22.83	37.52	22.99	37.42	23.15	44
45	38·57	23.18	38.47	23.34	38.37	23.51	38.27	23.68	45
46	39·43	23.69	39.33	23.86	39.22	24.04	39.12	24.21	46
47	40·29	24.21	40.18	24.38	40.07	24.56	39.97	24.73	47
48	41.14	24.72	41.04	24.90	40.93	25.08	40.82	25.26	48
49	42.00	25.24	41.89	25.42	41.78	25.60	41.67	25.78	49
50	42.86	25.75	42.75	25.94	42.63	26.12	42.52	26.31	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	59° 0′		58° 45′		58° 30′		58° 15′		

Dist.	32° 0′		32° 15′		32° 30′		32° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.85	0.53	0.85	0.53	0.84	0.54	0.84	0.54	1
2	1.70	1.06	1.69	1.07	1.69	1.07	1.68	1.08	2
3	2.54	1.59	2.54	1.60	2.53	1.61	2.52	1.62	3
4	3.39	2.12	3.38	2.13	3.37	2.15	3.36	2.16	4
5	4.24	2.65	4.23	2.67	4.22	2.69	4.21	2.70	5
6	5.09	3.18	5.07	3.20	5.06	3.22	5.05	3.25	6
7	5.94	3.71	5.92	3.74	5.90	3.76	5.89	3.79	7
8	6.78	4.24	6.77	4.27	6.75	4.30	6.73	4.33	8
9	7.63	4.77	7.61	4.80	7.59	4.84	7.57	4.87	9
10	8.48	5.30	8.46	5.34	8.43	5.37	8.41	5.41	10
11	9.33	5.83	9.30	5.87	9.28	5.91	9.25	5.95	11
12	10.18	6.36	10.15	6.40	10.12	6.45	10.09	6.49	12
13	11.02	6.89	10.99	6.94	10.96	6.98	10.93	7.03	13
14	11.87	7.42	11.84	7.47	11.81	7.52	11.77	7.57	14
15	12.72	7.95	12.69	8.00	12.65	8.06	12.62	8.11	15
16	13.57	8.48	13.53	8.54	13.49	8.60	13.46	8.66	16
17	14.42	9.01	14.38	9.07	14.34	9.13	14.30	9.20	17
18	15.26	9.54	15.22	9.60	15.18	9.67	15.14	9.74	18
19	16.11	10.07	16.07	10.14	16.02	10.21	15.98	10.28	19
20	16.96	10.60	16.91	10.67	16.87	10.75	16.82	10.82	20
21	17.81	11.13	17.76	11.21	17.71	11.28	17.66	11.36	21
22	18.66	11.66	18.61	11.74	18.55	11.82	18.50	11.90	22
23	19.51	12.19	19.45	12.27	19.40	12.36	19.34	12.44	23
24	20.35	12.72	20.30	12.81	20.24	12.90	20.18	12.98	24
25	21.20	13.25	21.14	13.34	21.08	13.43	21.03	13.52	25
26	22.05	13.78	21.99	13.87	21.93	13.97	21.87	14.07	26
27	22.90	14.31	22.83	14.41	22.77	14.51	22.71	14.61	27
28	23.75	14.84	23.68	14.94	23.61	15.04	23.55	15.15	28
29	24.59	15.37	24.53	15.47	24.46	15.58	24.39	15.69	29
30	25.44	15.90	25.37	16.01	25.30	16.12	25.23	16.23	30
31	26.29	16.43	26.22	16.54	26.15	16.66	26.07	16.77	31
32	27.14	16.96	27.06	17.08	26.99	17.19	26.91	17.31	32
33	27.99	17.49	27.91	17.61	27.83	17.73	27.75	17.85	33
34	28.83	18.02	28.75	18.14	28.68	18.27	28.60	18.39	34
35	29.68	18.55	29.60	18.68	29.52	18.81	29.44	18.93	35
36	30.53	19.08	30.45	19.21	30.36	19.34	30.28	19.47	36
37	31.38	19.61	31.29	19.74	31.21	19.88	31.12	20.02	37
38	32.23	20.14	32.14	20.28	32.05	20.42	31.96	20.56	38
39	33.07	20.67	32.98	20.81	32.89	20.95	32.80	21.10	39
40	33.92	21.20	33.83	21.34	33.74	21.49	33.64	21.64	40
41	34.77	21.73	34.67	21.88	34.58	22.03	34.48	22.18	41
42	35.62	22.26	35.52	22.41	35.42	22.57	35.32	22.72	42
43	36.47	22.79	36.37	22.95	36.27	23.10	36.16	23.26	43
44	37.31	23.32	37.21	23.48	37.11	23.64	37.01	23.80	44
45	38.16	23.85	38.06	24.01	37.95	24.18	37.85	24.34	45
46	39.01	24.38	38.90	24.55	38.80	24.72	38.69	24.88	46
47	39.86	24.91	39.75	25.08	39.64	25.25	39.53	25.43	47
48	40.71	25.44	40.60	25.61	40.48	25.79	40.37	25.97	48
49	41.55	25.97	41.44	26.15	41.33	26.33	41.21	26.51	49
50	42.40	26.50	42.29	26.68	42.17	26.86	42.05	27.05	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	58° 0′		57° 45′		57° 30′		57° 15′		

TRAVERSE TABLE.

Dist.	33° 0′		33° 15′		33° 30′		33° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.84	0.54	0.84	0.55	0.83	0.55	0.83	0.56	1
2	1·68	1.09	1.67	1.10	1.67	1.10	1.66	1.11	2
3	2.52	1.63	2.51	1.64	2.50	1.66	2.49	1.67	3
4	3.35	2.18	3.35	2.19	3.34	2.21	3.33	2.22	4
5	4.19	2.72	4.18	2.74	4.17	2.76	4.16	2.78	5
6	5.03	3.27	5.02	3.29	5.00	3.31	4.99	3.33	6
7	5.87	3.81	5.85	3.84	5.84	3.86	5.82	3.89	7
8	6.71	4.36	6.69	4.39	6.67	4.42	6.65	4.44	8
9	7.55	4.90	7.53	4.93	7.51	4.97	7.48	5.00	9
10	8.39	5.45	8.36	5.48	8.34	5.52	8.31	5.56	10
11	9.23	5.99	9.20	6.03	9.17	6.07	9.15	6.11	11
12	10.06	6.54	10.04	6.58	10.01	6.62	9.98	6.67	12
13	10.90	7.08	10.87	7.13	10.84	7.18	10.81	7.22	13
14	11.74	7.62	11.71	7.68	11.67	7.73	11.64	7.78	14
15	12.58	8.17	12.54	8.22	12.51	8.28	12.47	8.33	15
16	13.42	8.71	13.38	8.77	13.34	8.83	13.30	8.89	16
17	14.26	9.26	14.22	9.32	14.18	9.38	14.13	9.44	17
18	15.10	9.80	15.05	9.87	15.01	9.93	14.97	10.00	18
19	15.93	10.35	15.89	10.42	15.84	10.49	15.80	10.56	19
20	16.77	10.89	16.73	10.97	16.68	11.04	16.63	11.11	20
21	17·61	11.44	17.56	11 51	17·51	11.59	17.46	11.67	21
22	18.45	11.98	18.40	12.06	18.35	12.14	18.29	12.22	22
23	19.29	12.53	19.23	12.61	19.18	12.69	19.12	12.78	23
24	20.13	13.07	20.07	13.16	20.01	13.25	19.96	13.33	24
25	20.97	13.62	20.91	13.71	20.85	13.80	20.79	13.89	25
26	21.81	14.16	21.74	14.26	21.68	14.35	21.62	14.44	26
27	22.64	14.71	22.58	14.80	22.52	14.90	22.45	15.00	27
28	23.48	15.25	23.42	15.35	23.35	15.45	23.28	15.56	28
29	24.32	15.79	24.25	15.90	24.18	16.01	24.11	16.11	29
30	25.16	16.34	25.09	16.45	25.02	16.56	24.94	16.67	30
31	26.00	16.88	25.92	17.00	25.85	17.11	25.78	17.22	31
32	26.84	17.43	26.76	17.55	26.68	17.66	26.61	17.78	32
33	27.68	17.97	27.60	18.09	27.52	18.21	27.44	18.33	33
34	28.51	18.52	28.43	18.64	28.35	18.77	28.27	18.89	34
35	29.35	19.06	29.27	19.19	29.19	19.32	29.10	19.44	35
36	30.19	19.61	30.11	19.74	30.02	19.87	29.93	20.00	36
37	31.03	20.15	30.94	20.29	30.85	20.42	30.76	20.56	37
38	31.87	20.70	31.78	20.84	31.69	20.97	31.60	21.11	38
39	32.71	21.24	32.62	21.38	32.52	21.53	32.43	21.67	39
40	33.55	21.79	33.45	21.93	33.36	22.08	33.26	22.22	40
41	34.39	22.33	34.29	22.48	34.19	22.63	34.09	22.78	41
42	35.22	22.87	35.12	23.03	35.02	23.18	34.92	23.33	42
43	36.06	23.42	35.96	23.58	35.86	23.73	35.75	23.89	43
44	36.90	23.96	36.80	24.12	36.69	24.29	36.58	24.45	44
45	37.74	24.51	37.63	24.67	37.53	24.84	37.42	25.00	45
46	38.58	25.05	38.47	25.22	38.36	25.39	38.25	25.56	46
47	39.42	25.60	39 31	25.77	39.19	25.94	39.08	26.11	47
48	40·26	26.14	40.14	26.32	40.03	26.49	39.91	26.67	48
49	41.09	26.69	40.98	26.87	40.86	27.05	40.74	27.22	49
50	41.93	27.23	41.81	27.41	41.69	27.60	41.57	27.78	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	57° 0′		56° 45′		56° 30′		56° 15′		

Dist	34° 0'		34° 15'		34° 30'		34° 45'		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.83	0.56	0.83	0.56	0.82	0.57	0.82	0.57	1
2	1.66	1.12	1.65	1.13	1.65	1.13	1.64	1.14	2
3	2.49	1.68	2.48	1.69	2.47	1.70	2.46	1.71	3
4	3.32	2.24	3.31	2.25	3.30	2.27	3.29	2.28	4
5	4.15	2.80	4.13	2.81	4.12	2.83	4.11	2.85	5
6	4.97	3.36	4.96	3.38	4.94	3.40	4.93	3.42	6
7	5.80	3.91	5.79	3.94	5.77	3.96	5.75	3.99	7
8	6.63	4.47	6.61	4.50	6.59	4.53	6.57	4.56	8
9	7.46	5.03	7.44	5.07	7.42	5.10	7.39	5.13	9
10	8.29	5.59	8.27	5.63	8.24	5.66	8.22	5.70	10
11	9.12	6.15	9.09	6.19	9.07	6.23	9.04	6.27	11
12	9.95	6.71	9.92	6.75	9.89	6.80	9.86	6.84	12
13	10.78	7.27	10.75	7.32	10.71	7.36	10.68	7.41	13
14	11.61	7.83	11.57	7.88	11.54	7.93	11.50	7.98	14
15	12.44	8.39	12.40	8.44	12.36	8.50	12.32	8.55	15
16	13.26	8.95	13.23	9.00	13.19	9.06	13.15	9.12	16
17	14.09	9.51	14.05	9.57	14.01	9.63	13.97	9.69	17
18	14.92	10.07	14.88	10.13	14.83	10.20	14.79	10.26	18
19	15.75	10.62	15.71	10.69	15.66	10.76	15.61	10.83	19
20	16.58	11.18	16.53	11.26	16.48	11.33	16.43	11.40	20
21	17.41	11.74	17.36	11.82	17.31	11.89	17.25	11.97	21
22	18.24	12.30	18.18	12.38	18.13	12.46	18.08	12.54	22
23	19.07	12.86	19.01	12.94	18.95	13.03	18.90	13.11	23
24	19.90	13.42	19.84	13.51	19.78	13.59	19.72	13.68	24
25	20.73	13.98	20.66	14.07	20.60	14.16	20.54	14.25	25
26	21.56	14.54	21.49	14.63	21.43	14.73	21.36	14.82	26
27	22.38	15.10	22.32	15.20	22.25	15.29	22.18	15.39	27
28	23.21	15.66	23.14	15.76	23.08	15.86	23.01	15.96	28
29	24.04	16.22	23.97	16.32	23.90	16.43	23.83	16.53	29
30	24.87	16.78	24.80	16.88	24.72	16.99	24.65	17.10	30
31	25.70	17.33	25.62	17.45	25.55	17.56	25.47	17.67	31
32	26.53	17.89	26.45	18.01	26.37	18.13	26.29	18.24	32
33	27.36	18.45	27.28	18.57	27.20	18.69	27.11	18.81	33
34	28.19	19.01	28.10	19.14	28.02	19.26	27.94	19.38	34
35	29.02	19.57	28.93	19.70	28.84	19.82	28.76	19.95	35
36	29.85	20.13	29.76	20.26	29.67	20.39	29.58	20.52	36
37	30.67	20.69	30.58	20.82	30.49	20.96	30.40	21.09	37
38	31.50	21.25	31.41	21.39	31.32	21.52	31.22	21.66	38
39	32.33	21.81	32.24	21.95	32.14	22.09	32.04	22.23	39
40	33.16	22.37	33.06	22.51	32.97	22.66	32.87	22.80	40
41	33.99	22.93	33.89	23.07	33.79	23.22	33.69	23.37	41
42	34.82	23.49	34.72	23.64	34.61	23.79	34.51	23.94	42
43	35.65	24.05	35.54	24.20	35.44	24.36	35.33	24.51	43
44	36.48	24.60	36.37	24.76	36.26	24.92	36.15	25.08	44
45	37.31	25.16	37.20	25.33	37.09	25.49	36.97	25.65	45
46	38.14	25.72	38.02	25.89	37.91	26.05	37.80	26.22	46
47	38.96	26.28	38.85	26.45	38.73	26.62	38.62	26.79	47
48	39.79	26.84	39.68	27.01	39.56	27.19	39.44	27.36	48
49	40.62	27.40	40.50	27.58	40.38	27.75	40.26	27.93	49
50	41.45	27.96	41.33	28.14	41.21	28.32	41.08	28.50	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	56° 0'		55° 45'		55 30'		55° 15'		

Dist.	35° 0′		35° 15′		35° 30′		35° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.82	0.57	0.82	0.58	0.81	0.58	0.81	0.58	1
2	1.64	1.15	1.63	1.15	1.63	1.16	1.62	1.17	2
3	2.46	1.72	2.45	1.73	2.44	1.74	2.43	1.75	3
4	3.28	2.29	3.27	2.31	3.26	2.32	3.25	2.34	4
5	4.10	2.87	4.08	2.89	4.07	2.90	4.06	2.92	5
6	4.91	3.44	4.90	3.46	4.88	3.48	4.87	3.51	6
7	5.73	4.02	5.72	4.04	5.70	4.06	5.68	4.09	7
8	6.55	4.59	6.53	4.62	6.51	4.65	6.49	4.67	8
9	7.37	5.16	7.35	5.19	7.33	5.23	7.30	5.26	9
10	8.19	5.74	8.17	5.77	8.14	5.81	8.12	5.84	10
11	9.01	6.31	8.98	6.35	8.96	6.39	8.93	6.43	11
12	9.83	6.88	9.80	6.93	9.77	6.97	9.74	7.01	12
13	10.65	7.46	10.62	7.50	10.58	7.55	10.55	7.60	13
14	11.47	8.03	11.43	8.08	11.40	8.13	11.36	8.18	14
15	12.29	8.60	12.25	8.66	12.21	8.71	12.17	8.76	15
16	13.11	9.18	13.07	9.23	13.03	9.29	12.99	9.35	16
17	13.93	9.75	13.88	9.81	13.84	9.87	13.80	9.93	17
18	14.74	10.32	14.70	10.39	14.65	10.45	14.61	10.52	18
19	15.56	10.90	15.52	10.97	15.47	11.03	15.42	11.10	19
20	16.38	11.47	16.33	11.54	16.28	11.61	16.23	11.68	20
21	17.20	12.05	17.15	12.12	17.10	12.19	17.04	12.27	21
22	18.02	12.62	17.97	12.70	17.91	12.78	17.85	12.85	22
23	18.84	13.19	18.78	13.27	18.72	13.36	18.67	13.44	23
24	19.66	13.77	19.60	13.85	19.54	13.94	19.48	14.02	34
25	20.48	14.34	20.42	14.43	20.35	14.52	20.29	14.61	25
26	21.30	14.91	21.23	15.01	21.17	15.10	21.10	15.19	26
27	22.12	15.49	22.05	15.58	21.98	15.68	21.91	15.77	27
28	22.94	16.06	22.87	16.16	22.80	16.26	22.72	16.36	28
29	23.76	16.63	23.68	16.74	23.61	16.84	33.54	16.94	29
30	24.57	17.21	24.50	17.31	24.42	17.42	24.35	17.53	30
31	25.39	17.78	25.32	17.89	25.24	18.00	25.16	18.11	31
32	26.21	18.35	26.13	18.47	26.05	18.58	25.97	18.70	32
33	27.03	18.93	26.95	19.05	26.87	19.16	26.78	19.28	33
34	27.85	19.50	27.77	19.62	27.68	19.74	27.59	19.86	34
35	28.67	20.08	28.58	20.20	28.49	20.32	28.40	20.45	35
36	29.49	20.65	29.40	20.78	29.31	20.91	29.22	21.03	36
37	30.31	21.22	30.22	21.35	30.12	21.49	30.03	21.62	37
38	31.13	21.80	31.03	21.93	30.94	22.07	30.84	22.20	38
39	31.95	22.37	31.85	22.51	31.75	22.65	31.65	22.79	39
40	32.77	22.94	32.67	23.09	32.56	23.23	32.46	23.37	40
41	33.59	23.52	33.48	23.66	33.38	23.81	33.27	23.95	41
42	34.40	24.09	34.30	24.24	34.19	24.39	34.09	24.54	42
43	35.22	24.66	35.12	24.82	35.01	24.97	34.90	25.12	43
44	36.04	25.24	35.93	25.39	35.82	25.55	35.71	25.71	44
45	36.86	25.81	36.75	25.97	36.64	26.13	36.52	26.29	45
46	37.68	26.38	37.57	26.55	37.45	26.71	37.33	26.88	46
47	38.50	26.96	38.38	27.13	38.26	27.29	38.14	27.46	47
48	39.32	27.53	39.20	27.70	39.08	27.87	38.96	28.04	48
49	40.14	28.11	40.02	28.28	39.89	28.45	39.77	28.63	49
50	40.96	28.68	40.83	28.86	40.71	29.04	40.58	29.21	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	55° 0′		54° 45′		54° 30′		54° 15′		

Dist.	36° 0′		36° 15′		36° 30°		36° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.81	0.59	0.81	0.59	0.80	0.59	0.80	0.60	1
2	1.62	1.18	1.61	1.18	1.61	1.19	1.60	1.20	2
3	2.43	1.76	2.42	1.77	2.41	1.78	2.40	1.79	3
4	3 24	2 35	3.23	2.37	3.22	2.38	3.20	2.39	4
5	4.05	2.94	4.03	2.96	4.02	2.97	4.01	2.99	5
6	4.85	3.53	4.84	3.55	4.82	3.57	4.81	3.59	6
7	5.66	4.11	5.65	4.14	5.63	4.16	5.61	4.19	7
8	6.47	4.70	6.45	4.73	6.43	4.76	6.41	4.79	8
9	7.28	5.29	7.26	5.32	7.23	5.35	7.21	5.38	9
10	8.09	5.88	8.06	5.91	8.04	5.95	8.01	5.98	10
11	8.90	6.47	8.87	6.50	8.84	6.54	8.81	6.58	11
12	9.71	7.05	9.68	7.10	9.65	7.14	9.61	7.18	12
13	10.52	7.64	10.48	7.69	10.45	7.73	10.42	7.78	13
14	11.33	8.23	11.29	8.28	11.25	8.33	11.22	8.38	14
15	12.14	8.82	12.10	8.87	12 06	8.92	12.02	8.97	15
16	12.94	9.40	12.90	9.46	12.86	9.52	12.82	9.57	16
17	13.75	9.99	13.71	10.05	13.67	10.11	13.62	10.17	17
18	14.56	10.58	14.52	10.64	14.47	10.71	14.42	10.77	18
19	15.37	11.17	15.32	11.23	15.27	11.30	15.22	11.37	19
20	16.18	11.76	16.13	11.83	16.08	11.90	16.02	11.97	20
21	16.99	12.34	16.94	12.42	16.88	12.49	16.83	12.56	21
22	17.80	12.93	17.74	13.01	17.68	13.09	17.63	13.16	22
23	18.61	13.52	18.55	13.60	18.49	13.68	18.43	13.76	23
24	19.42	14.11	19.35	14.19	19.29	14.28	19.23	14.36	24
25	20.23	14.69	20.16	14.78	20.10	14.87	20.03	14.96	25
26	21.03	15.28	20.97	15.37	20.90	15.47	20.83	15.56	26
27	21.84	15.87	21.77	15.97	21.70	16.06	21.63	16.15	27
28	22.65	16.46	22.58	16.56	22.51	16.65	22.43	16.75	28
29	23.46	17.05	23.39	17.15	23.31	17.25	23.24	17.35	29
30	24.27	17.63	24.19	17.74	24.12	17.84	24.04	17.95	30
31	25.08	18.22	25.00	18.33	24.92	18.44	24.84	18.55	31
32	25.89	18.81	25.81	18.92	25.72	19.03	25.64	19.15	32
33	26.70	19.40	26.61	19.51	26.53	19.63	26.44	19.74	33
34	27.51	19.98	27.42	20.10	27.33	20.22	27.24	20.34	34
35	28.32	20.57	28.23	20 70	28.14	20.82	28.04	20.94	35
36	29.12	21.16	29.03	21.29	28.94	21.41	28.84	21.54	36
37	29.93	21.75	29.84	21.88	29.74	22.01	29.65	22.14	37
38	30.74	22.34	30.64	22.47	30.55	22.60	30.45	22.74	38
39	31.55	22.92	31.45	23.06	31.35	23.20	31.25	23.33	39
40	32.36	23.51	32.26	23.65	32.15	23.79	32.05	23.93	40
41	33.17	24.10	33.06	24.24	32.96	24.39	32.85	24.53	41
42	33.98	24.69	33.87	24.84	33.76	24.98	33.65	25.13	42
43	34.79	25.27	34.68	25.43	34.57	25.58	34.45	25.73	43
44	35.60	25.86	35.48	26.02	35.37	26.17	35.25	26.33	44
45	36.41	26.45	36.29	26.61	36.17	26.77	36.06	26.92	45
46	37.21	27.04	37.10	27.20	36.98	27.36	36.86	27.52	46
47	38.02	27.63	37.90	27.79	37.78	27.96	37.66	28.12	47
48	38.83	28.21	38.71	28.38	38.59	28.55	38.46	28.72	48
49	39.64	28.80	39.52	28.97	39.39	29.15	39.26	29.32	49
50	40.45	29.39	40.32	29.57	40.19	29.74	40.06	29.92	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	54° 0′		53° 45′		53° 30′		53° 15′		

Dist.	37° 0′		37° 15′		37° 30′		37° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.80	0.60	0.80	0.61	0.79	0.61	0.79	0.61	1
2	1.60	1.20	1.59	1.21	1.59	1.22	1.58	1.22	2
3	2.40	1.81	2.39	1.82	2.38	1.83	2.37	1.84	3
4	3.19	2.41	3.18	2.42	3.17	2.44	3.16	2.45	4
5	3.99	3.01	3.98	3.03	3.97	3.04	3.95	3 06	5
6	4.79	3.61	4.78	3.63	4.76	3.65	4.74	3.67	6
7	5.59	4.21	5.57	4.24	5.55	4.26	5.53	4.29	7
8	6.39	4.81	6.37	4.84	6.35	4.87	6.33	4.90	8
9	7.19	5.42	7.16	5.45	7.14	5.48	7.12	5.51	9
10	7.99	6.02	7.96	6.05	7.93	6.09	7.91	6.12	10
11	8.79	6.62	8.76	6.66	8.73	6.70	8.70	6.73	11
12	9.58	7.22	9.55	7.26	9.52	7.31	9.49	7.35	12
13	10.38	7.82	10.35	7.87	10.31	7.91	10.28	7.96	13
14	11.18	8.43	11.14	8.47	11.11	8.52	11.07	8.57	14
15	11.98	9.03	11.94	9.08	11.90	9.13	11.86	9.18	15
16	12.78	9.63	12.74	9.68	12.69	9.74	12.65	9.80	16
17	13.58	10.23	13.53	10.29	13.49	10.35	13.44	10.41	17
18	14.38	10.83	14.33	10.90	14.28	10.96	14.23	11.02	18
19	15.17	11.43	15.12	11.50	15.07	11.57	15.02	11.63	19
20	15.97	12.04	15.92	12.11	15.87	12.18	15.81	12 24	20
21	16.77	12.64	16.72	12.71	16.66	12.78	16.60	12.86	21
22	17.57	13.24	17.51	13.32	17.45	13.39	17.40	13.47	22
23	18.37	13.84	18.31	13.92	18.25	14.00	18.19	14.08	23
24	19.17	14.44	19.10	14.53	19.04	14.61	18.98	14.69	24
25	19.97	15.05	19.90	15.13	19.83	15.22	19.77	15.31	25
26	20.76	15.65	20.70	15.74	20.63	15.83	20.56	15.92	26
27	21.56	16.25	21.49	16.34	21.42	16.44	21.35	16.53	27
28	22.36	16.85	22.29	16.95	22.21	17.05	22.14	17.14	28
29	23.16	17.45	23.08	17.55	23.01	17.65	22.93	17.75	29
30	23.96	18.05	23.88	18.16	23.80	18.26	23.72	18.37	30
31	24.76	18.66	24.68	18.76	24.59	18.87	24.51	18.98	31
32	25.56	19.26	25.47	19.37	25.39	19.48	25.30	19.59	32
33	26.36	19.86	26.27	19.97	26.18	20.09	26.09	20.20	33
34	27.15	20.46	27.06	20.58	26.97	20.70	26.88	20.82	34
35	27.95	21.06	27.86	21.19	27.77	21.31	27.67	21.43	35
36	28.75	21.67	28.66	21.79	28.56	21.92	28.46	22.04	36
37	29.55	22.27	29.45	22.40	29.35	22.52	29.26	22.65	37
38	30.35	22.87	30.25	23.00	30.15	23.13	30.05	23.26	38
39	31.15	23.47	31.04	23.61	30.94	23.74	30.84	23.88	39
40	31.95	24.07	31.84	24.21	31.73	24.35	31.63	24.49	40
41	32.74	24.67	32.64	24.82	32.53	24.96	32.42	25.10	41
42	33.54	25.28	33.43	25.42	33.32	25.57	33.21	25.71	42
43	34.34	25.88	34.23	26.03	34.11	26.18	34.00	26.33	43
44	35.14	26.48	35.02	26.63	34.91	26.79	34.79	26.94	44
45	35.94	27.08	35.82	27.24	35.70	27.39	35.58	27.55	45
46	36.74	27.68	36.62	27.84	36.49	28.00	36.37	28.16	46
47	37.54	28.29	37.41	28.45	37.29	28.61	37.16	28.77	47
48	38.33	28.89	38.21	29.05	38.08	29.22	37.95	29.39	48
49	39.13	29.49	39.00	29.66	38.87	29.83	38.74	30.00	49
50	39.93	30.09	39.80	30.26	39.67	30.44	39.53	30.61	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	53° 0′		52° 45′		52° 30′		52° 15′		

Dist.	38° 0'		38° 15'		38° 30'		38° 45'		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.79	0.62	0.79	0.62	0.78	0.62	0.78	0.63	1
2	1.58	1.23	1.57	1.24	1.57	1.25	1.56	1.25	2
3	2.36	1.85	2.36	1.86	2.35	1.87	2.34	1.88	3
4	3.15	2.46	3.14	2.48	3.13	2.49	3.12	2.50	4
5	3.94	3.08	3.93	3.10	3.91	3.11	3.90	3.13	5
6	4.73	3.69	4.71	3.71	4.70	3.74	4.68	3.76	6
7	5.52	4.31	5.50	4.33	5.48	4.36	5.46	4.38	7
8	6.30	4.93	6.28	4.95	6.26	4.98	6.24	5.01	8
9	7.09	5.54	7.07	5.57	7.04	5.60	7.02	5.63	9
10	7.88	6.16	7.85	6.19	7.83	6.23	7.80	6.26	10
11	8.67	6.77	8.64	6.81	8.61	6.85	8.58	6.89	11
12	9.46	7.39	9.42	7.43	9.39	7.47	9.36	7.51	12
13	10.24	8.00	10.21	8.05	10.17	8.09	10.14	8.14	13
14	11.03	8.62	10.99	8.67	10.96	8.72	10.92	8.76	14
15	11.82	9.23	11.78	9.29	11.74	9.34	11.70	9.39	15
16	12.61	9.85	12.57	9.91	12.52	9.96	12.48	10.01	16
17	13.40	10.47	13.35	10.52	13.30	10.58	13.26	10.64	17
18	14.18	11.08	14.14	11.14	14.09	11.21	14.04	11.27	18
19	14.97	11.70	14.92	11.76	14.87	11.83	14.82	11.89	19
20	15.76	12.31	15.71	12.38	15.65	12.45	15.60	12.52	20
21	16.55	12.93	16.49	13.00	16.43	13.07	16.38	13.14	21
22	17.34	13.54	17.28	13.62	17.22	13.70	17.16	13.77	22
23	18.12	14.16	18.06	14.24	18.00	14.32	17.94	14.40	23
24	18.91	14.78	18.85	14.86	18.78	14.94	18.72	15.02	24
25	19.70	15.39	19.63	15.48	19.57	15.56	19.50	15.65	25
26	20.49	16.01	20.42	16.10	20.35	16.19	20.28	16.27	26
27	21.28	16.62	21.20	16.72	21.13	16.81	21.06	16.90	27
28	22.06	17.24	21.99	17.33	21.91	17.43	21.84	17.53	28
29	22.85	17.85	22.77	17.95	22.70	18.05	22.62	18.15	29
30	23.64	18.47	23.56	18.57	23.48	18.68	23.40	18.78	30
31	24.43	19.09	24.34	19.19	24.26	19.30	24.18	19.40	31
32	25.22	19.70	25.13	19.81	25.04	19.92	24.96	20.03	32
33	26.00	20.32	25.92	20.43	25.83	20.54	25.74	20.66	33
34	26.79	20.93	26.70	21.05	26.61	21.17	26.52	21.28	34
35	27.58	21.55	27.49	21.67	27.39	21.79	27.30	21.91	35
36	28.37	22.16	28.27	22.29	28.17	22.41	28.08	22.53	36
37	29.16	22.78	29.06	22.91	28.96	23.03	28.86	23.16	37
38	29.94	23.40	29.84	23.53	29.74	23.66	29.64	23.78	38
39	30.73	24.01	30.63	24.14	30.52	24.28	30.42	24.41	39
40	31.52	24.63	31.41	24.76	31.30	24.90	31.20	25.04	40
41	32.31	25.24	32.20	25.38	32.09	25.52	31.98	25.66	41
42	33.10	25.86	32.98	26.00	32.87	26.15	32.75	26.29	42
43	33.88	26.47	33.77	26.62	33.65	26.77	33.53	26.91	43
44	34.67	27.09	34.55	27.24	34.43	27.39	34.31	27.54	44
45	35.46	27.70	35.34	27.86	35.22	28.01	35.09	28.17	45
46	36.25	28.32	36.12	28.48	36.00	28.64	35.87	28.79	46
47	37.04	28.94	36 91	29.10	36.78	29.26	36.65	29.42	47
48	37.82	29.55	37.70	29.72	37.57	29.88	37.43	30.04	48
49	38.61	30.17	38.48	30.34	38.35	30.50	38.21	30.67	49
50	39.40	30.78	39.27	30.95	39 13	31.13	38.99	31.30	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	52° 0'		51° 45'		51° 30'		51° 15'		

Dist.	39° 0′		39° 15′		39° 30′		39° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.78	0.63	0.77	0.63	0.77	0.64	0.77	0.64	1
2	1.55	1.26	1.55	1.27	1.54	1.27	1.54	1.28	2
3	2.33	1.89	2.32	1.90	2.31	1.91	2.31	1.92	3
4	3.11	2.52	3.10	2.53	3.09	2.54	3.08	2.56	4
5	3.89	3.15	3.87	3.16	3.86	3.18	3.84	3.20	5
6	4.66	3.78	4.65	3.80	4.63	3.82	4.61	3.84	6
7	5.44	4.41	5.42	4.43	5.40	4.45	5.38	4.48	7
8	6.22	5.03	6.20	5.06	6.17	5.09	6.15	5.12	8
9	6.99	5.66	6.97	5.69	6.94	5.72	6.92	5.76	9
10	7.77	6.29	7.74	6.33	7.72	6.36	7.69	6.39	10
11	8.55	6.92	8.52	6.96	8.49	7.00	8.46	7.03	11
12	9.33	7.55	9.29	7.59	9.26	7.63	9.23	7.67	12
13	10.10	8.18	10.07	8.23	10.03	8.27	9.99	8.31	13
14	10.88	8.81	10.84	8.86	10.80	8.91	10.76	8.95	14
15	11.66	9.44	11.62	9.49	11.57	9.54	11.53	9.59	15
16	12.43	10.07	12.39	10.12	12.35	10.18	12.30	10.23	16
17	13.21	10.70	13.16	10.76	13.12	10.81	13.07	10.87	17
18	13.99	11.33	13.94	11.39	13.89	11.45	13.84	11.51	18
19	14.77	11.96	14.71	12.02	14.66	12.09	14.61	12.15	19
20	15.54	12.59	15.49	12.65	15.43	12.72	15.38	12.79	20
21	16.32	13.22	16.26	13.29	16.20	13.36	16.15	13.43	21
22	17.10	13.84	17.04	13.92	16.98	13.99	16.91	14.07	22
23	17.87	14.47	17.81	14.55	17.75	14.63	17.68	14.71	23
24	18.65	15.10	18.59	15.19	18.52	15.27	18.45	15.35	24
25	19.43	15.73	19.36	15.82	19.29	15.90	19.22	15.99	25
26	20.21	16.36	20.13	16.45	20.06	16.54	19.99	16.63	26
27	20.98	16.99	20.91	17.08	20.83	17.17	20.76	17.26	27
28	21.76	17.62	21.68	17.72	21.61	17.81	21.53	17.90	28
29	22.54	18.25	22.46	18.35	22.38	18.45	22.30	18.54	29
30	23.31	18.88	23.23	18.98	23.15	19.08	23.07	19.18	30
31	24.09	19.51	24.01	19.61	23.92	19.72	23.83	19.82	31
32	24.87	20.14	24.78	20.25	24.69	20.35	24.60	20.46	32
33	25.65	20.77	25.55	20.88	25.46	20.99	25.37	21.10	33
34	26.42	21.40	26.33	21.51	26.24	21.63	26.14	21.74	34
35	27.20	22.03	27.10	22.14	27.01	22.26	26.91	22.38	35
36	27.98	22.66	27.88	22.78	27.78	22.90	27.68	23.02	36
37	28.75	23.28	28.65	23.41	28.55	23.53	28.45	23.66	37
38	29.53	23.91	29.43	24.04	29.32	24.17	29.22	24.30	38
39	30.31	24.54	30.20	24.68	30.09	24.81	29.98	24.44	39
40	31.09	25.17	30.98	25.31	30.86	25.44	30.75	25.58	40
41	31.86	25.80	31.75	25.94	31.64	26.08	31.52	26.22	41
42	32.64	26.43	32.52	26.57	32.41	26.72	32.29	26.86	42
43	33.42	27.06	33.30	27.21	33.18	27.35	33.06	27.50	43
44	34.19	27.69	34.07	27.84	33.95	27.99	33.83	28.14	44
45	34.97	28.32	34.85	28.47	34.72	28.62	34.60	28.77	45
46	35.75	28.95	35.62	29.10	35.49	29.26	35.37	29.41	46
47	36.53	29.58	36.40	29.74	36.27	29.90	36.14	30.05	47
48	37.30	30.21	37.17	30.37	37.04	30.53	36.90	30.69	48
49	38.08	30.84	37.95	31.00	37.81	31.17	37.67	31.33	49
50	38.86	31.47	38.72	31.64	38.58	31.80	38.44	31.97	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep	Lat.	Dist.
	51° 0′		50° 45′		50° 30′		50° 15′		

Dist.	40° 0'		40° 15'		40° 30'		40° 45'		Dist.
	Lat.	Dep	Lat.	Dep.	Lat.	Dep.	Lat.	Dep	
1	0.77	0.64	0.76	0.65	0.76	0.65	0.76	0.65	1
2	1.53	1.29	1.53	1.29	1.52	1.30	1.52	1.31	2
3	2.30	1.93	2.29	1.94	2.28	1.95	2.27	1.96	3
4	3.06	2.57	3.05	2.58	3.04	2.60	3.03	2.61	4
5	3.83	3.21	3.82	3.23	3.80	3.25	3.79	3.26	5
6	4.60	3,36	4.58	3.88	4.56	3.90	4.55	3.92	6
7	5.36	4.50	5.34	4,52	5.32	4.55	5·30	4.57	7
8	6.13	5.14	6.11	5.17	6.08	5.20	6.06	5.22	8
9	6.89	5.79	6.87	5.82	6.84	5.85	6.82	5.87	9
10	7.66	6,43	7.63	6.46	7.60	6.49	7 58	6.53	10
11	8.43	7.07	8.40	7.11	8.36	7.14	8.33	7.18	11
12	9.19	7.71	9.16	7.75	9.12	7.79	9.09	7.83	12
13	9.96	8.36	9.92	8,40	9.89	8.44	9.85	8.49	13
14	10.72	9.00	10.69	9.05	10.65	9.09	10.61	9.14	14
15	11.49	9.64	11.45	9.69	11.41	9.74	11.36	9.79	15
16	12,26	10.28	12.21	10.34	12.17	10.39	12,12	10.44	16
17	13.02	10.93	12.97	10.98	12.93	11.04	12.88	11.10	17
18	13.79	11.57	13.74	11.63	13.69	11.69	13.64	11.75	18
19	14.55	12.21	14.50	12.28	14.45	12.34	14.39	12.40	19
20	15.32	12.86	15.26	12,92	15.21	12.99	15.15	13.06	20
21	16.09	13.50	16.03	13.57	15.97	13.64	15.91	13.71	21
22	16.85	14.14	16.79	14,21	16.73	14.29	16.67	14.36	22
23	17.62	14.78	17.55	14.86	17.49	14.94	17.42	15.01	23
24	18.38	15.43	18,32	15.51	18.25	15.59	18.18	15.67	24
25	19.15	16.07	19,08	16.15	19.01	16.24	18.94	16.32	25
26	19.92	16.71	19.84	16.80	19.77	16.89	19.70	16.97	26
27	20.68	17.36	20.61	17,45	20.53	17.54	20.45	17.62	27
28	21.45	18.00	21.37	18.09	21.29	18.18	21.21	18.28	28
29	22.22	18.64	22.13	18.74	22.05	18.83	21.97	18.93	29
30	22.98	19.28	22.90	19.38	22.81	19.48	22.73	19.58	30
31	23.75	19.93	23.66	20.03	23.57	20.13	23.48	20,24	31
32	24.51	20.57	24.42	20.68	24.33	20.78	24.24	20.89	32
33	25.28	21.21	25.19	21.32	25.09	21.43	25.00	21.54	33
34	26.05	21.85	25.95	21,97	25.85	22.08	25.76	22.19	34
35	26.81	22.50	26.71	22.61	26.61	22.73	26.51	22.85	35
36	27.58	23.14	27.48	23.26	27.37	23.38	27.27	23.50	36
37	28.34	23.78	28.24	23.91	28.14	24.03	28.03	24.15	37
38	29.11	24.43	29.00	24.55	28.90	24.68	28.79	24.80	38
39	29.88	25.07	29.77	25.20	29.66	25.33	29.54	25.46	39
40	30.64	25.71	30.53	25.84	30.42	25.98	30.30	26.11	40
41	31.41	26.35	31.29	26.49	31.18	26.63	31.06	26.76	41
42	32.17	27.00	32.06	27.14	31.94	27.28	31.82	27.42	42
43	32.94	27.64	32.82	27.78	32.70	27.93	32.58	28.07	43
44	33.71	28.28	33.58	28.43	33.46	28.58	33.33	28.72	44
45	34.47	28.93	34.35	29.08	34.22	29.23	34.09	29.37	45
46	35.24	29.57	35.11	29.72	34.98	29.87	34.85	30.03	46
47	36.00	30.21	35.87	30.37	35.74	30.52	35.61	30.68	47
48	36.77	30.85	36.64	31.01	36.50	31.17	36.36	31.33	48
49	37.54	31.50	37.40	31.66	37.26	31.82	37.12	31.99	49
50	37.30	32.14	38.16	32.31	38.02	32.47	38.88	32.64	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	50° 0'		49° 45'		49' 30'		49° 15'		

Dist.	41° 0′		41° 15′		41° 30′		41° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.75	0.66	0.75	0.66	0.75	0.66	0.75	0.67	1
2	1.51	1.31	1.50	1.32	1.50	1.33	1.49	1.33	2
3	2.26	1.97	2.26	1.98	2.25	1.99	2.24	2.00	3
4	3.02	2.62	3.01	2.64	3.00	2.65	2.98	2.66	4
5	3.77	3.28	3.76	3.30	3.74	3.31	3.73	3.33	5
6	4.53	3.94	4.51	3.96	4.49	3.98	4·48	4.00	6
7	5.28	4.59	5.26	4.62	5.24	4.64	5.22	4.66	7
8	6.04	5.25	6.01	5.27	5.99	5.30	5.97	5.33	8
9	6.79	5.90	6.77	5.93	6·74	5.96	6.71	5.99	9
10	7.55	6.56	7.52	6.59	7.49	6.63	7.46	6.66	10
11	8.30	7.22	8.27	7.25	8.24	7.29	8.21	7.32	11
12	9.06	7.87	9.02	7.91	8.99	7.95	8.95	7.99	12
13	9.81	8.53	9.77	8.57	9.74	8.61	9.70	8.66	13
14	10.57	9.18	10.53	9.23	10.49	9.28	10.44	9.32	14
15	11.32	9.84	11.28	9.89	11.23	9.94	11.19	9.99	15
16	12.08	10.50	12.03	10.55	11.98	10.60	11.94	10.65	16
17	12.83	11.15	12.78	11.21	12.73	11.26	12.68	11.32	17
18	13.58	11.81	13.53	11.87	13.48	11.93	13.43	11.99	18
19	14.34	12.47	14.28	12.53	14.23	12.59	14.18	12.65	19
20	15.09	13.12	15.04	13.19	14.98	13.25	14.92	13.32	20
21	15.85	13.78	15.79	13.85	15.73	13.92	15.67	13.98	21
22	16·60	14.43	16.54	14.51	16.48	14.58	16.41	14.65	22
23	17.36	15.09	17.29	15.17	17.23	15.24	17.16	15.32	23
24	18.11	15.75	18.04	15.82	17.98	15.90	17.91	15.98	24
25	18.87	16.40	18.80	16.48	18.72	16.57	18.65	16.65	25
26	19.62	17.06	19.55	17.14	19.47	17.23	19.40	17.31	26
27	20.38	17.71	20.30	17.80	20.22	17.89	20.14	17.98	27
28	21.13	18.37	21.05	18.46	20.97	18.55	20.89	18.64	28
29	21.89	19.03	21.80	19.12	21.72	19.22	21.64	19.31	29
30	22.64	19.68	22.56	19.78	22.47	19.88	22.38	19.98	30
31	23.40	20.34	23.31	20.44	23.22	20.54	23.13	20.64	31
32	24.15	20.99	24.06	21.10	23.97	21.20	23.87	21.31	32
33	24.91	21.65	24.81	21.76	24.72	21.87	24.62	21.97	33
34	25.66	22.31	25.56	22.42	25.46	22.53	25.37	22.64	34
35	26.41	22.96	26.31	23.08	26.21	23.19	26.11	23.31	35
36	27.17	23.62	27.07	23.74	26.96	23.85	26.86	23.97	36
37	27.92	24.27	27.82	24 40	27.71	24.52	27.60	24.64	37
38	28.68	24.93	28.57	25.06	28.46	25.18	28.35	25.30	38
39	29.43	25.59	29.32	25.71	29.21	25.84	29.10	25.97	39
40	30.19	26.24	30.07	26.37	29.96	26.50	29.84	26.64	40
41	30.94	26.90	30.83	27.03	30.71	27.17	30.59	27.30	41
42	31.70	27.55	31.58	27.69	31.46	27.83	31.33	27.97	42
43	32.45	28.21	32.33	28.35	32.21	28.49	32.08	28.63	43
44	33.21	28.87	33.08	29.01	32.95	29.16	32.83	29.30	44
45	33.96	29.52	33.83	29.67	33.70	29.82	33.57	29.96	45
46	34.72	30.18	34.58	30.33	34.45	30.48	34.32	30.63	46
47	35.47	30.83	35.34	30.99	35.20	31.14	35.06	31.30	47
48	36.23	31.49	36.09	31.65	35.95	31.81	35.81	31.96	48
49	36.98	32.15	36.84	32.31	36.70	32.47	36.56	32.63	49
50	37.74	32.80	37.59	32.97	37.45	33.13	37.30	33.29	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	49° 0′		48° 45′		48° 30′		48° 15′		

Dist.	42° 0′		42° 15′		42° 30′		42° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.74	0.67	0.74	0.67	0.74	0.68	0.73	0.68	1
2	1.49	1.34	1.48	1.34	1.47	1.35	1.47	1.36	2
3	2.23	2.01	2.22	2.02	2.21	2.03	2.20	2.04	3
4	2.97	2.68	2.96	2.69	2.95	2.70	2.94	2.72	4
5	3.72	3.35	3.70	3.36	3.69	3.38	3.67	3.39	5
6	4.46	4.01	4.44	4.03	4.42	4.05	4.41	4.07	6
7	5.20	4.68	5.18	4.71	5.16	4.73	5.14	4.75	7
8	5.95	5.35	5.92	5.38	5.90	5.40	5.87	5.43	8
9	6.69	6.02	6.66	6.05	6.64	6.08	6.61	6.11	9
10	7.43	6.69	7.40	6.72	7.37	6.76	7.34	6.79	10
11	8.17	7.36	8.14	7.40	8.11	7.43	8.08	7.47	11
12	8.92	8.03	8.88	8.07	8.85	8.11	8.81	8.15	12
13	9.66	8.70	9.62	8.74	9.58	8.78	9.55	8.82	13
14	10.40	9.37	10.36	9.41	10.32	9.46	10.28	9.50	14
15	11.15	10.04	11.10	10.09	11.06	10.13	11.01	10.18	15
16	11.89	10.71	11.84	10.76	11.80	10.81	11.75	10.86	16
17	12.63	11.38	12.58	11.43	12.53	11.49	12.48	11.54	17
18	13.38	12.04	13.32	12.10	13.27	12.16	13.22	12.22	18
19	14.12	12.71	14.06	12.78	14.01	12.84	13.95	12.90	19
20	14.86	13.38	14.80	13.45	14.75	13.51	14.69	13.58	20
21	15.61	14.05	15.54	14.12	15.48	14.19	15.42	14.25	21
22	16.35	14.72	16.28	14.79	16.22	14.86	16.16	14.93	22
23	17.09	15.39	17.03	15.46	16.96	15.54	16.89	15.61	23
24	17.84	16.06	17.77	16.14	17.69	16.21	17.62	16.29	24
25	18.58	16.73	18.51	16.81	18.43	16.89	18.36	16.97	25
26	19.32	17.40	19.25	17.48	19.17	17.57	19.09	17.65	26
27	20.06	18.07	19.99	18.15	19.91	18.24	19.83	18.33	27
28	20.81	18.74	20.73	18.83	20.64	18.92	20.56	19.01	28
29	21.55	19.40	21.47	19.50	21.38	19.59	21.30	19.69	29
30	22.29	20.07	22.21	20.17	22.12	20.27	22.03	20.36	30
31	23.04	20.74	22.95	20.84	22.86	30.94	22.76	21.04	31
32	23.78	21.41	23.69	21.52	23.59	21.62	23.50	21.72	32
33	24.52	22.08	24.43	22.19	24.33	22.29	24.23	22.40	33
34	25.27	22.75	25.17	22.86	25.07	22.97	24.97	23.08	34
35	26.01	23.42	25.91	23.53	25.80	23.64	25.70	23.76	35
36	26.75	24.09	26.65	24.21	26.54	24.32	26.44	24.44	36
37	27.50	24.76	27.39	24.88	27.28	25.00	27.17	25.12	37
38	28.24	25.43	28.13	25.55	28.02	25.67	27.90	25.79	38
39	28.98	26.10	28.87	26.22	28.75	26.35	28.64	26.47	39
40	29.73	26.77	29.61	26.89	29.49	27.02	29.37	27.15	40
41	30.47	27.43	30.35	27.57	30.23	27.70	30.11	27.83	41
42	31.21	28.10	31.09	28.24	30.97	28.37	30.84	28.51	42
43	31.96	28.77	31.83	28.91	31.70	29.05	31.58	29.19	43
44	32.70	29.44	32.57	29.58	32.44	29.73	32.31	29.87	44
45	33.44	30.11	33.31	30.26	33.18	30.40	33.04	30.55	45
46	34.18	30.78	34.05	30.93	33.91	31.08	33.78	31.22	46
47	34.93	31.45	34.79	31.60	34.65	31.75	34.51	31.90	47
48	35.67	32.12	35.53	32.27	35.39	32.43	35.25	32.58	48
49	36.41	32.79	36.27	32.95	36.13	33.10	35.98	33.26	49
50	37.16	33.46	37.01	33.62	36.86	33.78	36.72	33.94	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	48° 0′		47° 45′		47° 30′		47° 15′		

Dist.	43° 0′		43° 15′		43° 30′		43° 45′		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.73	0.68	0.73	0.69	0.73	0.69	0.72	0.69	1
2	1.46	1.36	1.46	1.37	1.45	1.38	1.44	1.38	2
3	2.19	2.05	2.19	2.06	2.18	2.07	2.17	2.07	3
4	2.93	2.73	2.91	2.74	2.90	2.75	2.89	2.77	4
5	3.66	3.41	3.64	3.43	3.63	3.44	3.61	3.46	5
6	4.39	4.09	4.37	4.11	4.35	4.13	4.33	4.15	6
7	5.12	4.77	5.10	4.80	5.08	4.82	5.06	4.84	7
8	5.85	5.46	5.83	5.48	5.80	5.51	5.78	5.53	8
9	6.58	6.14	6·56	6.17	6.53	6.20	6.50	6.22	9
10	7.31	6.82	7.28	6.85	7.25	6.88	7.22	6.92	10
11	8.04	7.50	8.01	7.54	7.98	7.57	7.95	7.61	11
12	8.78	8.18	8.74	8.82	8.70	8.26	8.67	8.30	12
13	9.51	8.87	9.47	8.91	9.43	8.95	9.39	8.99	13
14	10.24	9.55	10.20	9.59	10.16	9.64	10.11	9.68	14
15	10.97	10.23	10.93	10.28	10.88	10.33	10.84	10.37	15
16	11.70	10.91	11.65	10.96	11.61	11.01	11.56	11.06	16
17	12.43	11.59	12.38	11.65	12.33	11.70	12.28	11.76	17
18	13.16	12.28	13.11	12.33	13.06	12.39	13.00	12.45	18
19	13.90	12.96	13.84	13.02	13.78	13.08	13.72	13.14	19
20	14.63	13.64	14.57	13.70	14.51	13.77	14.45	13.83	20
21	15.36	14.32	15.30	14.39	15.23	14.46	15.17	14.52	21
22	16.09	15.00	16.02	15.07	15.96	15.14	15.89	15.21	22
23	16.82	15.69	16.75	15.76	16.68	15.83	16.61	15.90	23
24	17.55	16.37	17.48	16.44	17.41	16.52	17.34	16.60	24
25	18.28	17.05	18.21	17.13	18.13	17.21	18.06	17.29	25
26	19.02	17.73	18.94	17.81	18.86	17.90	18.78	17.98	26
27	19.75	18.41	19.67	18.50	19.58	18.59	19.50	18.67	27
28	20.48	19.10	20.39	19.19	20.31	19.27	20.23	19.36	28
29	21.21	19.78	21.12	19.87	21.04	19.96	20.95	20.05	29
30	21.94	20.46	21.85	20.56	21.76	20.65	21.67	20.75	30
31	22.67	21.14	22.58	21.24	22.49	21.34	22.39	21.44	31
32	23.40	21.82	23.31	21.93	23.21	22.03	23.12	22.13	32
33	24.13	22.51	24.04	22.61	23.94	22.72	23.84	22.82	33
34	24.87	26.19	24.76	23.30	24.66	23.40	24.56	23.51	34
35	25.60	23.87	25.49	23.98	25.39	24.09	25.28	24.20	35
36	26.33	24.55	26.22	24.67	26.11	24.78	26.00	24.89	36
37	27.06	25.23	26.95	25.35	26.84	25.47	26.73	25.59	37
38	27.79	25.92	27.68	26.04	27.56	26.16	27.45	26.28	38
39	28.52	26.60	28.41	26.72	28.29	26.85	28.17	26.97	39
40	29.25	27.28	29.13	27.41	29.01	27.53	28.89	27.66	40
41	29.99	27.96	29.86	28.09	29.74	28.22	29.62	28.35	41
42	30.72	28.64	30.59	28.78	30.47	28.91	30.34	29.04	42
43	31.45	29.33	31.32	29.46	31.19	29.60	31.06	29.73	43
44	32.18	30.01	32.05	30.15	31.92	30.29	31.78	30.43	44
45	32.91	30.69	32.78	30.83	32.64	30.98	32.51	31.12	45
46	33.64	31.37	33.51	31.52	33.37	31.66	33.23	31.81	46
47	34.37	32.05	34.23	32.20	34.09	32.35	33.95	32.50	47
48	35.10	32.74	34.96	32.89	34.82	33.04	34.67	33.19	48
49	35.84	33.42	35.69	33.57	35.54	33.73	35.40	33.88	49
50	36.57	34.10	36.42	34.26	36.27	34.42	36.12	34.58	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	47° 0′		46° 45′		46° 30′		46° 15′		

Dist.	36° 0'		36° 15'		36° 30'		36° 45'		Dist.
	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	
1	0.81	0.59	0.81	0.59	0.80	0.59	0.80	0.60	1
2	1.62	1.18	1.61	1.18	1.61	1.19	1.60	1.20	2
3	2.43	1.76	2.42	1.77	2.41	1.78	2.40	1.79	3
4	3 24	2 35	3.23	2.37	3.22	2.38	3.20	2.39	4
5	4.05	2.94	4.03	2.96	4.02	2.97	4.01	2.99	5
6	4.85	3.53	4.84	3.55	4.82	3.57	4.81	3.59	6
7	5.66	4.11	5.65	4.14	5.63	4.16	5.61	4.19	7
8	6.47	4.70	6.45	4.73	6.43	4.76	6.41	4.79	8
9	7.28	5.29	7.26	5.32	7.23	5.35	7.21	5.38	9
10	8.09	5.88	8.06	5.91	8.04	5.95	8.01	5.98	10
11	8.90	6.47	8.87	6.50	8.84	6.54	8.81	6.58	11
12	9.71	7.05	9.68	7.10	9.65	7.14	9.61	7.18	12
13	10.52	7.64	10.48	7.69	10.45	7.73	10.42	7.78	13
14	11.33	8.23	11.29	8.28	11.25	8.33	11.22	8.38	14
15	12.14	8.82	12.10	8.87	12 06	8.92	12.02	8.97	15
16	12.94	9.40	12.90	9.46	12.86	9.52	12.82	9.57	16
17	13.75	9.99	13.71	10.05	13.67	10.11	13.62	10.17	17
18	14.56	10.58	14.52	10.64	14.47	10.71	14.42	10.77	18
19	15.37	11.17	15.32	11.23	15·27	11.30	15.22	11.37	19
20	16.18	11.76	16.13	11.83	16.08	11.90	16.02	11.97	20
21	16.99	12.34	16.94	12.42	16.88	12.49	16.83	12.56	21
22	17.80	12.93	17.74	13.01	17.68	13.09	17.63	13.16	22
23	18.61	13.52	18.55	13.60	18.49	13.68	18.43	13.76	23
24	19.42	14.11	19.35	14.19	19.29	14.28	19.23	14.36	24
25	20.23	14.69	20.16	14.78	20.10	14.87	20.03	14.96	25
26	21.03	15.28	20.97	15.37	20.90	15.47	20.83	15.56	26
27	21.84	15.87	21.77	15.97	21.70	16.06	21.63	16.15	27
28	22.65	16.46	22.58	16.56	22.51	16.65	22.43	16.75	28
29	23.46	17.05	23.39	17.15	23.31	17.25	23.24	17.35	29
30	24.27	17.63	24.19	17.74	24.12	17.84	24.04	17.95	30
31	25.08	18.22	25.00	18.33	24.92	18.44	24.84	18.55	31
32	25.89	18.81	25.81	18.92	25.72	19.03	25.64	19.15	32
33	26.70	19.40	26.61	19.51	26.53	19.63	26.44	19.74	33
34	27.51	19.98	27.42	20.10	27.33	20.22	27.24	20.34	34
35	28.32	20.57	28.23	20 70	28.14	20.82	28.04	20.94	35
36	29.12	21.16	29.03	21.29	28.94	21.41	28.84	21.54	36
37	29.93	21.75	29.84	21.88	29.74	22.01	29.65	22.14	37
38	30.74	22.34	30.64	22.47	30.55	22.60	30.45	22.74	38
39	31.55	22.92	31.45	23.06	31.35	23.20	31.25	23.33	39
40	32.36	23.51	32.26	23.65	32.15	23.79	32.05	23.93	40
41	33.17	24.10	33.06	24.24	32.96	24.39	32.85	24.53	41
42	33.98	24.69	33.87	24.84	33.76	24.98	33.65	25.13	42
43	34.79	25.27	34.68	25.43	34.57	25.58	34.45	25.73	43
44	35.60	25.86	35.48	26.02	35.37	26.17	35.25	26.33	44
45	36.41	26.45	36.29	36.61	36.17	26.77	36.06	26.92	45
46	37.21	27.04	37.10	27.20	36.98	27.36	36.86	27.52	46
47	38.02	27.63	37.90	27.79	37.78	27.96	37.66	28.12	47
48	38.83	28.21	38.71	28.38	38.59	28.55	38.46	28.72	48
49	39.64	28.80	39.52	28.97	39.39	29.15	39.26	29.32	49
50	40.45	29.39	40.32	29.57	40.19	29.74	40.06	29.92	50
Dist.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dep.	Lat.	Dist.
	54° 0'		53° 45'		53° 30'		53° 15'		

II. *A Table of Natural Sines, calculated to five places of figures, for every Minute.*

Natural Sines are Decimals bearing the same proportion to Unity or 1 that the Sine of the corresponding number of Degrees and Minutes bears to Radius or Sine of 90°. That is, 1 is assumed as the Nat. Sine of 90°, and the Table calculated accordingly.

Explanation of the Table.

To find the Natural Sine of any number of Degrees and Minutes.

If the Degrees be less than 45, look for them at the Top of the Columns, and for the Minutes at the left hand; but if more than 45, look for them at the Bottom, and for the Minutes at the Right hand; under or over the Degrees and against the Minutes will be the Natural Sine required.

The reverse of this will give the Degrees and Minutes corresponding to any Natural Sine.

Note. As the size of the Type on which this Table is printed did not admit of putting 60 Minutes on a page, it will be observed that some of the Degrees begin at the Top and some below the Top of the page; and the Minutes are placed accordingly.

To calculate the Northing or Southing, &c. for any Course and Distance, by Nat. Sines.

Find the Nat. Sine and Co-Sine of the Course, and into each of these multiply the Distance; the Products will be the Latitude and Departure required.

Example.

Required the Latitude and Departure for 6 *Chains and* 22 *Links, on a Course N.* 38° 27′ *W.*

Nat Sine of 38° 27′	0.62183	Nat. Co-Sine	0.78315
	6.22		6.22
	124366		156630
	124366		156630
	373098		469890
	3.8677826		4.8711930

Answer. Northing 4.87 Westing 3.87

M	0 Deg.		1 Deg.		2 Deg.		3 Deg.		M
	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	
0	00000	Unit	01745	99985	03490	99939	05234	99863	60
1	29	00	774	84	519	38	263	61	59
2	58	00	803	84	548	37	292	60	58
3	87	00	832	83	577	36	321	58	57
4	116	00	862	83	606	35	350	57	56
5	145	00	891	82	635	34	379	55	55
6	175	00	920	82	664	33	408	54	54
7	204	00	949	81	693	32	437	52	53
8	233	00	978	80	723	31	466	51	52
9	262	00	02007	80	752	30	495	49	51
10	291	00	036	79	781	29	524	47	50
11	320	99999	065	79	810	27	553	46	49
12	349	99	094	78	839	26	582	44	48
13	378	99	123	77	868	25	611	42	47
14	407	99	152	77	897	24	640	41	46
15	436	99	181	76	926	23	669	39	45
16	00465	99999	02211	99976	03955	99922	05698	99838	44
17	495	99	240	75	984	21	727	36	43
18	524	99	269	74	04013	19	756	34	42
19	553	98	298	74	042	18	785	33	41
20	582	98	327	73	071	17	814	31	40
21	611	98	356	72	100	16	844	29	39
22	640	98	385	72	129	15	873	27	38
23	669	98	414	71	159	13	902	26	37
24	698	98	443	70	188	12	931	24	36
25	727	97	472	69	217	11	960	22	35
26	756	97	501	69	246	10	989	21	34
27	785	97	530	68	275	09	06018	19	33
28	814	97	560	67	304	07	047	17	32
29	844	96	589	66	333	06	076	15	31
30	873	96	618	66	362	05	105	13	30
31	00902	99996	02647	99965	04391	99904	06134	99812	29
32	931	96	676	64	420	02	163	10	28
33	960	95	705	63	449	01	192	08	27
34	989	95	734	63	478	00	221	06	26
35	01018	95	763	62	507	99898	250	04	25
36	047	95	792	61	536	97	279	03	24
37	076	94	821	60	565	96	308	01	23
38	105	94	850	59	594	94	337	99799	22
39	134	94	879	59	623	93	366	97	21
40	164	93	908	58	653	92	395	95	20
41	193	93	938	57	682	90	424	93	19
42	222	93	967	56	711	89	453	92	18
43	251	92	996	55	740	88	482	90	17
44	280	92	03025	54	769	86	511	88	16
45	309	91	054	53	798	85	540	86	15
M	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	M
	89 Deg.		88 Deg.		87 Deg.		86 Deg.		

M.	0 Deg.		1 Deg.		2 Deg.		3 Deg.		M
	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	
46	01338	99991	03083	99952	04827	99883	06569	99784	14
47	367	91	112	52	856	82	598	82	13
48	396	90	141	51	885	81	627	80	12
49	425	90	170	50	914	79	656	78	11
50	454	89	199	49	943	78	685	76	10
51	483	89	228	48	972	76	714	74	9
52	513	89	257	47	05001	75	743	72	8
53	542	88	286	46	030	73	773	70	7
54	571	88	316	45	059	72	802	68	6
55	600	87	345	44	088	70	831	66	5
56	629	87	374	43	117	69	860	64	4
57	658	86	403	42	146	67	889	62	3
58	687	86	432	41	175	66	918	60	2
59	716	85	461	40	205	64	947	58	1
M	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	M
	89 Deg.		88 Deg.		87 Deg.		86 Deg.		

M	4 Deg.		5 Deg.		6 Deg.		7 Deg.		M
	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	
0	06976	99756	08716	99619	10453	99452	12187	99255	60
1	07005	54	745	17	482	49	216	51	59
2	034	52	774	14	511	46	245	48	58
3	063	50	803	12	540	43	274	44	57
4	092	48	831	09	569	40	302	40	56
5	121	46	860	07	597	37	331	37	55
6	150	44	889	04	626	34	360	33	54
7	179	42	918	02	655	31	389	30	53
8	208	40	947	99599	684	28	418	26	52
9	237	38	976	96	713	24	447	22	51
10	266	36	09005	94	742	21	476	19	50
11	295	34	034	91	771	18	504	15	49
12	324	31	063	88	800	15	533	11	48
13	353	29	092	86	829	12	562	08	47
14	382	27	121	83	858	09	591	04	46
15	411	25	150	80	887	06	620	00	45
16	07440	99723	09179	99578	10916	99402	12649	99197	44
17	469	21	208	75	945	99399	678	93	43
18	498	19	237	72	973	96	706	89	42
19	527	16	266	70	11002	93	735	86	41
20	556	14	295	67	031	90	764	82	40
21	585	12	324	64	060	86	793	78	39
22	614	10	353	62	089	83	822	75	38
23	643	08	382	59	118	80	851	71	37
24	672	05	411	56	147	77	880	67	36
25	701	03	440	53	176	74	908	63	35
26	730	01	469	51	205	70	937	60	34
27	759	99699	498	48	234	67	966	56	3
28	788	96	527	45	263	64	995	52	3
29	817	94	556	42	291	60	13024	48	3
30	846	92	585	40	320	57	053	44	30
M	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	M
	85 Deg.		84 Deg.		83 Deg.		82 Deg.		

M	4 Deg.		5 Deg.		6 Deg.		7 Deg.		M
	N. S.	N.C.S.	N. S.	N.C.S	N. S.	N.C.S.	N. S.	N.C.S.	
31	07875	99689	09614	99537	11349	99354	13081	99141	29
32	904	87	642	34	378	51	110	37	28
33	933	85	671	31	407	47	139	33	27
34	962	83	700	28	436	44	168	29	26
35	991	80	729	26	465	41	197	25	25
36	08020	78	758	23	494	37	226	22	24
37	049	76	787	20	523	34	254	18	23
38	078	73	816	17	552	31	283	14	22
39	107	71	845	14	580	27	312	10	21
40	136	68	874	11	609	24	341	06	20
41	165	66	903	08	638	20	370	02	19
42	194	64	932	06	667	17	399	99098	18
43	223	61	961	03	696	14	427	94	17
44	252	59	990	00	725	10	456	91	16
45	281	57	10019	99497	754	07	485	87	15
46	08310	99654	10048	99494	11783	99303	13514	99083	14
47	339	52	077	91	812	00	543	79	13
48	368	49	106	88	840	99297	572	75	12
49	397	47	135	85	869	93	600	71	11
50	426	44	164	82	898	90	629	67	10
51	455	42	192	79	927	86	658	63	9
52	484	39	221	76	956	83	687	59	8
53	513	37	250	73	985	79	716	55	7
54	542	35	279	70	12014	76	744	51	6
55	571	32	308	67	043	72	773	47	5
56	600	30	337	64	071	69	802	43	4
57	629	27	366	61	100	65	831	39	3
58	658	25	395	58	129	62	860	35	2
59	687	22	424	55	158	58	889	31	1
M	N.C.S.	N.S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	M
	85 Deg.		84 Deg.		83 Deg.		82 Deg.		

M	8 Deg.		9 Deg.		10 Deg.		11 Deg.		M
	N. S.	N.C.S.	N.S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	
0	13917	99027	15643	98769	17365	98481	19081	98163	60
1	946	23	672	64	393	76	109	57	59
2	975	19	701	60	422	71	138	52	58
3	14004	15	730	55	451	66	167	46	57
4	033	11	758	51	479	61	195	40	56
5	061	06	787	46	508	55	224	35	55
6	090	02	816	41	537	50	252	29	54
7	119	98998	845	37	565	45	281	24	53
8	148	94	873	32	594	40	309	18	52
9	177	90	902	28	623	35	338	12	51
10	205	86	931	23	651	30	366	07	50
11	234	82	959	18	680	25	395	01	49
12	263	78	988	14	708	20	423	98096	48
13	292	73	16017	09	737	14	452	90	47
14	320	69	046	04	766	09	481	84	46
15	349	65	074	00	794	04	509	79	45
M	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	M
	81 Deg.		80 Deg.		79 Deg.		78 Deg.		

M	8 Deg.		9 Deg.		10 Deg.		11 Deg.		M
	Nat. Sine	N. Co-Sine	Nat. Sine.	N. Co-Sine.	Nat. Sine.	N. Co-Sine	Nat. Sine	N. Co-Sine	
16	14378	98961	16103	98695	17823	98399	19538	98073	44
17	407	57	132	90	852	94	566	67	43
18	436	53	160	86	880	89	595	61	42
19	464	48	189	81	909	83	623	56	41
20	493	44	218	76	937	78	652	50	40
21	522	40	246	71	966	73	680	44	39
22	551	36	275	67	995	68	709	39	38
23	580	31	304	62	18023	62	737	33	37
24	608	27	333	57	052	57	766	27	36
25	637	23	361	52	081	52	794	21	35
26	666	19	390	48	109	47	823	16	34
27	695	14	419	43	138	41	851	10	33
28	723	10	447	38	166	36	880	04	32
29	752	06	476	33	195	31	908	97998	31
30	781	02	505	29	224	25	937	92	30
31	14810	98897	16533	98624	18252	98320	19965	97987	29
32	838	93	562	19	281	15	994	81	28
33	867	89	591	14	309	10	20022	75	27
34	896	84	620	09	338	04	051	69	26
35	925	80	648	04	367	98299	079	63	25
36	954	76	677	00	395	94	108	58	24
37	982	71	706	98595	424	88	136	52	23
38	15011	67	734	90	452	83	165	46	22
39	040	63	763	85	481	77	193	40	21
40	069	58	792	80	509	72	222	34	20
41	097	54	820	75	538	67	250	28	19
42	126	49	849	70	567	61	279	22	18
43	155	45	878	65	595	56	307	16	17
44	184	41	906	61	624	50	336	10	16
45	212	36	935	56	652	45	364	05	15
46	15241	98832	16964	98551	18681	98240	20393	97899	14
47	270	27	992	46	710	34	421	93	13
48	299	23	17021	41	738	29	450	87	12
49	327	18	050	36	767	23	478	81	11
50	356	14	078	31	795	18	507	75	10
51	385	09	107	26	824	12	535	69	9
52	414	05	136	21	852	07	563	63	8
53	442	00	164	16	881	01	592	57	7
54	471	98796	193	11	910	98196	620	51	6
55	500	91	222	06	938	90	649	45	5
56	529	87	250	01	967	85	677	39	4
57	557	82	279	98496	995	79	706	33	3
58	586	78	308	91	19024	74	734	27	2
59	615	73	336	86	052	68	763	21	1
M	N. Co-Sine	Nat. Sine	N. Co-Sine.	Nat. Sine.	N. Co-Sine.	Nat. Sine	N. Co-Sine	Nat. Sine	M
	81 Deg.		80 Deg.		79 Deg.		78 Deg.		

M	12 Deg.		13 Deg.		14 Deg.		15 Deg.		M
	Nat. Sine	N. Co-Sine	Nat Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	
0	20791	97815	22495	97437	24192	97030	25882	96593	60
1	820	809	523	430	220	023	910	585	59
2	848	803	552	424	249	015	938	578	58
3	877	797	580	417	277	008	966	570	57
4	905	791	608	411	305	001	994	562	56
5	933	784	637	404	333	96994	26022	555	55
6	962	778	665	398	362	987	050	547	54
7	990	772	693	391	390	980	079	540	53
8	21019	766	722	384	418	973	107	532	52
9	047	760	750	378	446	966	135	524	51
10	076	754	778	371	474	959	163	517	50
11	104	748	807	365	503	952	191	509	49
12	132	742	835	358	531	945	219	502	48
13	161	735	863	351	559	937	247	494	47
14	189	729	892	345	587	930	275	486	46
15	218	723	920	338	615	923	303	479	45
16	21246	97717	22948	97331	24644	96916	26331	96471	44
17	275	711	977	325	672	909	359	463	43
18	303	705	23005	318	700	902	387	456	42
19	331	698	033	311	728	894	415	448	41
20	360	692	062	304	756	887	443	440	40
21	388	686	090	298	784	880	471	433	39
22	417	680	118	291	813	873	500	425	38
23	445	673	146	284	841	866	528	417	37
24	474	667	175	278	869	858	556	410	36
25	502	661	203	271	897	851	584	402	35
26	530	655	231	264	925	844	612	394	34
27	559	648	260	257	953	837	640	386	33
28	587	642	288	251	982	829	668	379	32
29	616	636	316	244	25010	822	696	371	31
30	644	630	345	237	038	815	724	363	30
31	21672	97623	23373	97230	25066	96807	26752	96355	29
32	701	617	401	223	094	800	780	347	28
33	729	611	429	217	122	793	808	340	27
34	758	604	458	210	151	786	836	332	26
35	786	598	486	203	179	778	864	324	25
36	814	592	514	196	207	771	892	316	24
37	843	585	542	189	235	764	920	308	23
38	871	579	571	182	263	756	948	301	22
39	899	573	599	176	291	749	976	293	21
40	928	566	627	169	320	742	27004	285	20
41	956	560	656	162	348	734	032	277	19
42	985	553	684	155	376	727	060	269	18
43	22013	547	712	148	404	719	088	261	17
44	041	541	740	141	432	712	116	253	16
45	070	534	769	134	460	705	144	246	15
M	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	M
	77 Deg.		76 Deg.		75 Deg.		74 Deg.		

M	12 Deg.		13 Deg.		14 Deg.		15 Deg.		M
	N.S.	N.C.S.	N.S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	
46	22098	97528	23797	97127	25488	96697	27172	96238	14
47	126	521	825	120	516	690	200	230	13
48	155	515	853	113	545	682	228	222	12
49	183	508	882	106	573	675	256	214	11
50	212	502	910	100	601	667	284	206	10
51	240	496	938	093	629	660	312	198	9
52	268	489	966	086	657	653	340	190	8
53	297	483	995	079	685	645	368	182	7
54	325	476	24023	072	713	638	396	174	6
55	353	470	051	065	741	630	424	166	5
56	382	463	079	058	769	623	452	158	4
57	410	457	108	051	798	615	480	150	3
58	438	450	136	044	826	608	508	142	2
59	467	444	164	037	854	600	536	134	1
M	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N. S.	N.C.S.	N.S.	M
	77 Deg.		76 Deg.		75 Deg.		74 Deg.		

M	16 Deg.		17 Deg.		18 Deg.		19 Deg.		M
	N.S	N.C.S.	N.S.	N.C.S	N. S.	N.C.S.	N. S.	N.C.S.	
0	27564	96126	29237	95630	30902	95106	32557	94552	60
1	592	118	265	622	929	097	584	542	59
2	620	110	293	613	957	088	612	533	58
3	648	102	321	605	985	079	639	523	57
4	676	094	348	596	31012	070	667	514	56
5	704	086	376	588	040	061	694	504	55
6	731	078	404	579	068	052	722	495	54
7	759	070	432	571	095	043	749	485	53
8	787	062	460	562	123	033	777	476	52
9	815	054	487	554	151	024	804	466	51
10	843	046	515	545	178	015	832	457	50
11	871	037	543	536	206	006	859	447	49
12	899	029	571	528	233	94997	887	438	48
13	927	021	699	519	261	988	914	428	47
14	955	013	626	511	289	979	942	418	46
15	983	005	654	502	316	970	969	409	45
16	28011	95997	29682	95493	31344	94961	32997	94399	44
17	039	989	710	485	372	952	33024	390	43
18	067	981	737	476	399	943	051	380	42
19	095	972	765	467	427	933	079	370	41
20	123	964	793	459	454	924	106	361	40
21	150	956	821	450	482	915	134	351	39
22	178	948	849	441	510	906	161	342	38
23	206	940	876	433	537	897	189	332	37
24	234	931	904	424	565	888	216	322	36
25	262	923	932	415	593	878	244	313	35
26	290	915	960	407	620	869	271	303	34
27	318	907	987	398	648	860	298	293	33
28	346	898	30015	389	675	851	326	284	32
29	374	890	043	380	703	842	353	274	31
30	402	882	071	372	730	832	381	264	30
M	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N. S.	N.C.S.	N. S.	M
	73 Deg.		72 Deg.		71 Deg.		70 Deg.		

M	16 Deg.		17 Deg.		18 Deg.		19 Deg.		M
	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	
31	28429	95874	30098	95363	31758	94823	33408	94254	29
32	457	865	126	354	786	814	436	245	28
33	485	857	154	345	813	805	463	235	27
34	513	849	182	337	841	795	490	225	26
35	541	841	209	328	868	786	518	215	25
36	569	832	237	319	896	777	545	206	24
37	597	824	265	310	923	768	573	196	23
38	625	816	292	301	951	758	600	186	22
39	652	807	320	293	979	749	627	176	21
40	680	799	348	284	32006	740	655	167	20
41	708	791	376	275	034	730	682	157	19
42	736	782	403	266	061	721	710	147	18
43	764	774	431	257	089	712	737	137	17
44	792	766	359	248	116	702	764	127	16
45	820	757	486	240	144	693	792	118	15
46	28847	95749	30514	95231	32171	94684	33819	94108	14
47	875	740	542	222	199	674	846	098	13
48	903	732	570	213	227	665	874	088	12
49	931	724	597	204	254	656	901	078	11
50	959	715	625	195	282	646	929	068	10
51	987	707	653	186	309	637	956	058	9
52	29015	698	680	177	337	627	983	049	8
53	042	690	708	168	364	618	34011	039	7
54	070	681	736	159	392	609	038	029	6
55	098	673	763	150	419	599	065	019	5
56	126	664	791	142	447	590	093	009	4
57	154	656	819	133	474	580	120	93999	3
58	182	647	846	124	502	571	147	989	2
59	209	639	874	115	529	561	175	979	1
M	N.C.S.	N, S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	M
	73 Deg.		72 Deg.		71 Deg.		70 Deg.		

M	20 Deg.		21 Deg.		22 Deg.		23 Deg.		M
	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	
0	34202	93969	35837	93358	37461	92718	39073	92050	60
1	229	959	864	348	488	707	100	039	59
2	257	949	891	337	515	697	127	028	58
3	284	939	918	327	542	686	153	016	57
4	311	929	945	316	569	675	180	005	56
5	339	919	973	306	595	664	207	91994	55
6	366	909	36000	295	622	653	234	982	54
7	393	899	027	285	649	642	260	971	53
8	421	889	054	274	676	631	287	959	52
9	448	879	081	264	703	620	314	948	51
10	475	869	108	253	730	609	341	936	50
11	503	859	135	243	757	598	367	925	49
12	530	849	162	232	784	587	394	914	48
13	557	839	190	222	811	576	421	902	47
14	584	829	217	211	838	565	448	891	46
15	612	819	244	201	865	554	474	879	45
M	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	M
	69 Deg.		68 Deg.		67 Deg.		66 Deg.		

	20 Deg.		21 Deg.		22 Deg.		23 Deg.		
M	Nat. Sine	N. Co-Sine	Nat. Sine	N Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	M
16	34639	93809	36271	93190	37892	92543	39501	91868	44
17	666	799	298	180	919	532	528	856	43
18	694	789	325	169	946	521	555	845	42
19	721	779	352	159	973	510	581	833	41
20	748	769	379	148	999	499	608	822	40
21	775	759	406	137	38026	488	635	810	39
22	803	748	434	127	053	477	661	799	38
23	830	738	461	116	080	466	688	787	37
24	857	728	488	106	107	455	715	775	36
25	884	718	515	095	134	444	741	764	35
26	912	708	542	084	161	432	768	752	34
27	939	698	569	074	188	421	795	741	33
28	966	688	596	063	215	410	822	729	32
29	993	677	623	052	241	399	848	718	31
30	35021	667	650	042	268	388	875	706	30
31	35048	93657	36677	93031	38295	92377	39902	91694	29
32	075	647	704	020	322	366	928	683	28
33	102	637	731	010	349	355	955	671	27
34	130	626	758	92999	376	343	982	660	26
35	157	616	785	988	403	332	40008	648	25
36	184	606	812	978	430	321	035	636	24
37	211	596	839	967	456	310	062	625	23
38	239	585	867	956	483	299	088	613	22
39	266	575	894	945	510	287	115	601	21
40	293	565	921	935	537	276	141	590	20
41	320	555	948	924	564	265	168	578	19
42	347	544	975	913	591	254	195	566	18
43	375	534	37002	902	617	243	221	555	17
44	402	524	029	892	644	231	248	543	16
45	429	514	056	881	671	220	275	531	15
46	35456	93503	37083	92870	38698	92209	40301	91519	14
47	484	493	110	859	725	198	328	508	13
48	511	483	137	849	752	186	355	496	12
49	538	472	164	838	778	175	381	484	11
50	565	462	191	827	805	164	408	472	10
51	592	452	218	816	832	152	434	461	9
52	619	441	245	805	859	141	461	449	8
53	647	431	272	794	886	130	488	437	7
54	674	420	299	784	912	119	514	425	6
55	701	410	326	773	939	107	541	414	5
56	728	400	353	762	966	096	567	402	4
57	755	389	380	751	993	085	594	390	3
58	782	379	407	740	39020	073	621	378	2
59	810	368	434	729	046	062	647	366	1
M	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine.	N. Co-Sine.	Nat. Sine.	N. Co-Sine.	Nat. Sine.	M
	69 Deg.		68 Deg.		67 Deg.		66 Deg.		

M	24 Deg.		25 Deg.		26 Deg.		27 Deg.		M
	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co Sine.	Nat. Sine.	N. Co-Sine	
0	40674	91355	42262	90631	43837	89879	45399	89101	60
1	700	343	288	618	863	867	425	087	59
2	727	331	315	606	889	854	451	074	58
3	753	319	341	594	916	841	477	061	57
4	780	307	367	582	942	828	503	048	56
5	806	295	394	569	968	816	529	035	55
6	833	283	420	557	994	803	554	021	54
7	860	272	446	545	44020	790	580	008	53
8	886	260	473	532	046	777	606	88995	52
9	913	248	499	520	072	764	632	981	51
10	939	236	525	507	098	752	658	968	50
11	966	224	552	495	124	739	684	955	49
12	992	212	578	483	151	726	710	942	48
13	41019	200	604	470	177	713	736	928	47
14	045	188	631	458	203	700	762	915	46
15	072	176	657	446	229	687	787	902	45
16	41098	91164	42683	90433	44255	89674	45813	88888	44
17	125	152	709	421	281	662	839	875	43
18	151	140	736	408	307	649	865	862	42
19	178	128	762	396	333	636	891	848	41
20	204	116	788	383	359	623	917	835	40
21	231	104	815	371	385	610	942	822	39
22	257	092	841	358	411	597	968	808	38
23	284	080	867	346	437	584	994	795	37
24	310	068	894	334	464	571	46020	782	36
25	337	056	920	321	490	558	046	768	35
26	363	044	946	309	516	545	072	755	34
27	390	032	972	296	542	532	097	741	33
28	416	020	999	284	568	519	123	728	32
29	443	008	43025	271	594	506	149	715	31
30	469	90996	051	259	620	493	175	701	30
31	41496	90984	43077	90246	44646	89480	46201	88688	29
32	522	972	104	233	672	467	226	674	28
33	549	960	130	221	698	454	252	661	27
34	575	948	156	208	724	441	278	647	26
35	602	936	182	196	750	428	304	634	25
36	628	924	209	183	776	415	330	620	24
37	655	911	235	171	802	402	355	607	23
38	681	899	261	158	828	389	381	593	22
39	707	887	287	146	854	376	407	580	21
40	734	875	313	133	880	363	433	566	20
41	760	863	340	120	906	350	458	553	19
42	787	851	366	108	932	337	484	539	18
43	813	839	392	095	958	324	510	526	17
44	840	826	418	082	984	311	536	512	16
45	866	814	445	070	45010	298	561	499	15
M	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine.	Nat. Sine	M
	65 Deg.		64 Deg.		63 Deg.		62 Deg.		

M	24 Deg.		25 Deg.		26 Deg.		27 Deg.		M
	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	
46	41892	90802	43471	90057	45036	89285	46587	88485	14
47	919	790	497	045	063	272	613	472	13
48	945	778	523	032	088	259	639	458	12
49	972	766	549	019	114	245	664	445	11
50	998	753	575	007	140	232	690	431	10
51	42024	741	602	89994	166	219	716	417	9
52	051	729	628	931	192	206	742	404	8
53	077	717	654	968	218	193	767	390	7
54	104	704	680	956	243	180	793	377	6
55	130	692	706	943	269	167	819	363	5
56	156	680	733	930	295	153	844	349	4
57	183	668	759	918	321	140	870	336	3
58	209	655	785	905	347	127	896	322	2
59	235	643	811	892	373	114	921	308	1
M	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	M
	65 Deg.		64 Deg.		63 Deg.		62 Deg.		

M	28 Deg.		29 Deg.		30 Deg.		31 Deg.		M
	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	
0	46947	88295	48481	87462	50000	86603	51504	85717	60
1	973	281	506	448	025	588	529	702	59
2	999	267	532	434	050	573	554	687	58
3	47024	254	557	420	076	559	579	672	57
4	050	240	583	406	101	544	604	657	56
5	076	226	608	391	126	530	628	642	55
6	101	213	634	377	151	515	653	627	54
7	127	199	659	363	176	501	678	612	53
8	153	185	684	349	201	486	703	597	52
9	178	172	710	335	227	471	728	582	51
10	204	158	735	321	252	457	753	567	50
11	229	144	761	306	277	442	778	551	49
12	255	130	786	292	302	427	803	536	48
13	281	117	811	278	327	415	828	521	47
14	306	103	837	264	352	398	852	506	46
15	332	089	862	250	377	384	877	491	45
16	47358	88075	48888	87235	50403	86369	51902	85476	44
17	383	062	913	221	428	354	927	461	43
18	409	048	938	207	453	340	952	446	42
19	434	034	964	193	478	325	977	431	41
20	460	020	989	178	503	310	52002	416	40
21	486	006	49014	164	528	295	026	401	39
22	511	87993	040	150	553	281	051	385	38
23	537	979	065	136	578	266	076	370	37
24	562	965	090	121	603	251	101	355	36
25	588	951	116	107	628	237	126	340	35
26	614	937	141	093	654	222	151	325	34
27	639	923	166	079	679	207	175	310	33
28	665	909	192	064	704	192	200	294	32
29	690	896	217	050	729	178	225	279	31
30	716	882	242	036	754	163	250	264	30
M	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	M
	61 Deg.		60 Deg.		59 Deg.		58 Deg.		

M	28 Deg.		29 Deg.		30 Deg.		31 Deg.		M
	N.S.	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S.	N. S.	N.C.S.	
31	47741	87868	49268	87021	50779	86148	52275	85249	29
32	767	854	293	007	804	133	299	234	28
33	793	840	318	86993	829	119	324	218	27
34	818	826	344	978	854	104	349	203	26
35	844	812	369	964	879	089	374	188	25
36	869	798	394	949	904	074	399	173	24
37	895	784	419	935	929	059	423	157	23
38	920	770	445	921	954	045	448	142	22
39	946	756	470	906	979	030	473	127	21
40	971	743	495	892	51004	015	498	112	20
41	997	729	521	878	029	000	522	096	19
42	48022	715	546	863	054	85985	547	081	18
43	048	701	571	849	079	970	572	066	17
44	073	687	596	834	104	956	597	051	16
45	099	673	622	820	129	941	621	035	15
46	48124	87659	49647	86805	51154	85926	52646	85020	14
47	150	645	672	791	179	911	671	005	13
48	175	631	697	777	204	896	696	84989	12
49	201	617	723	762	229	881	720	974	11
50	226	603	748	748	254	866	745	959	10
51	252	589	773	733	279	851	770	943	9
52	277	575	798	719	304	836	794	928	8
53	303	561	824	704	329	821	819	913	7
54	328	546	849	690	354	806	844	897	6
55	354	532	874	675	379	792	869	882	5
56	379	518	899	661	404	777	893	866	4
57	405	504	924	646	429	762	918	851	3
58	430	490	950	632	454	747	943	836	2
59	456	476	975	617	479	732	967	820	1
M	N.C.S.	N. S.	N.C.S.	N.S.	N.C.S.	N. S.	N.C.S.	N.S.	M
	61 Deg.		60 Deg.		59 Deg.		58 Deg.		

M	32 Deg.		33 Deg.		34 Deg.		35 Deg.		M
	N. S.	N.C.S.	N.S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	
0	52992	84805	54464	83867	55919	82904	57358	81915	60
1	53017	789	488	851	943	887	381	899	59
2	041	774	513	835	968	871	405	882	58
3	066	759	537	819	992	855	429	865	57
4	091	743	561	804	56016	839	453	848	56
5	115	728	586	788	040	822	477	832	55
6	140	712	610	772	064	806	501	815	54
7	164	697	635	756	088	790	524	798	53
8	189	681	659	740	112	773	548	782	52
9	214	666	683	724	136	757	572	765	51
10	238	650	708	708	160	741	596	748	50
11	263	635	732	692	184	724	619	731	49
12	288	619	756	676	208	708	643	714	48
13	312	604	781	660	232	692	667	698	47
14	337	588	805	645	256	675	691	681	46
15	361	573	829	629	280	659	715	664	45
M	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	M
	57 Deg.		56 Deg.		55 Deg.		54 Deg.		

	32 Deg.		33 Deg.		34 Deg.		35 Deg.		
M	Nat. Sine	N. Co-Sine	Nat. Sine.	N. Co-Sine.	Nat. Sine.	N. Co-Sine	Nat. Sine	N. Co-Sine	M
16	53386	84557	54854	83613	56305	82643	57738	81647	44
17	411	542	878	597	329	626	762	631	43
18	435	526	902	581	353	610	786	614	42
19	460	511	927	565	377	593	809	597	41
20	484	495	951	549	401	577	833	580	40
21	509	480	975	533	425	561	857	563	39
22	534	464	999	517	449	544	881	546	38
23	558	448	55024	501	473	528	904	530	37
24	583	433	048	485	497	511	928	513	36
25	607	417	072	469	521	495	952	496	35
26	632	402	097	453	545	478	976	479	34
27	656	386	121	437	569	462	999	462	33
28	681	370	145	421	593	446	58023	445	32
29	705	355	169	405	617	429	047	428	31
30	730	339	194	389	641	413	070	412	30
31	53754	84324	55218	83373	56665	82396	58094	81395	29
32	779	308	242	356	689	380	118	378	28
33	804	292	266	340	713	363	141	361	27
34	828	277	291	324	736	347	165	344	26
35	853	261	315	308	760	330	189	327	25
36	877	245	339	292	784	314	212	310	24
37	902	230	363	276	808	297	236	293	23
38	926	214	388	260	832	281	260	276	22
39	951	198	412	244	856	264	283	259	21
40	975	182	436	228	880	248	307	242	20
41	54000	167	460	212	904	231	330	225	19
42	024	151	484	195	928	214	854	208	18
43	049	135	509	179	952	198	378	191	17
44	073	120	533	163	976	181	401	174	16
45	097	104	557	147	57000	165	425	157	15
46	54122	84088	55581	83131	57024	82148	58449	81140	14
47	146	072	605	115	047	132	472	123	13
48	171	057	630	098	071	115	496	106	12
49	195	041	654	082	095	098	519	089	11
50	220	025	678	066	119	082	543	072	10
51	244	009	702	050	143	065	567	055	9
52	269	83994	726	034	167	048	590	038	8
53	293	978	750	017	191	032	614	021	7
54	317	962	775	001	215	015	637	004	6
55	342	946	799	82985	238	81999	661	80987	[illegible]
56	366	930	823	969	262	982	684	970	[illegible]
57	391	915	847	953	286	965	708	953	[illegible]
58	415	899	871	936	310	949	731	936	[illegible]
59	440	883	895	920	334	932	755	919	[illegible]
M	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	M
	57 Deg.		56 Deg.		55 Deg.		54 Deg.		

M	36 Deg.		37 Deg.		38 Deg.		M
	N.S.	N.C.S.	N. S.	N.C.S.	N.S.	N.C.S.	
46	59856	80108	61245	79051	62615	77970	14
47	879	091	268	033	638	952	13
48	902	073	291	015	660	934	12
49	926	056	314	78998	683	916	11
50	949	038	337	980	706	897	10
51	972	021	360	962	728	879	9
52	995	003	383	944	751	861	8
53	60019	79986	406	926	774	843	7
54	042	968	429	908	796	824	6
55	065	951	451	891	819	806	5
56	089	934	474	873	842	788	4
57	112	916	497	855	864	769	3
58	135	899	520	837	887	751	2
59	158	881	543	819	909	733	1
M	N.C.S.	N.S.	N.C.S.	N. S.	N.C.S.	N.S.	M
	53 Deg.		52 Deg.		51 Deg.		

M	39 Deg.		40 Deg.		41 Deg.		M
	N.S.	N.C.S.	N. S.	N.C.S.	N.S.	N.C.S.	
0	62932	77715	64279	76604	65606	75471	60
1	955	696	301	586	628	452	59
2	977	678	323	567	650	433	58
3	63000	660	346	548	672	414	57
4	022	641	368	530	694	395	56
5	045	623	390	511	716	375	55
6	068	605	412	492	738	356	54
7	090	586	435	473	759	337	53
8	113	568	457	455	781	318	32
9	135	550	479	436	803	299	51
10	158	531	501	417	825	280	50
11	180	513	524	398	847	261	49
12	203	494	546	380	869	241	48
13	225	476	568	361	891	222	47
14	248	458	590	342	913	203	46
15	271	439	612	323	935	184	45
16	63293	77421	64635	76304	65956	75165	44
17	316	402	657	286	978	146	43
18	338	384	679	267	66000	126	42
19	361	366	701	248	022	107	41
20	383	347	723	229	044	088	40
21	406	329	746	210	066	069	39
22	428	310	768	192	088	050	38
23	451	292	790	173	109	030	37
24	473	273	812	154	131	011	36
25	496	255	834	135	153	74992	35
26	518	236	856	116	175	973	34
27	540	218	878	097	197	953	33
28	563	199	901	078	218	934	32
29	585	181	923	059	240	915	31
30	608	162	945	041	262	896	30
M	N.C.S.	N.S.	N.C.S.	N.S.	N.C.S	N.S.	M
	50 Deg.		49 Deg.		48 Deg.		

M	39 Deg.		40 Deg.		41 Deg.		M
	N. S.	N.C.S	N. S.	N.C.S	N.S.	N.C.S	
31	63630	77144	64967	76022	66284	74876	29
32	653	125	989	003	306	857	28
33	675	107	65011	75984	327	838	27
34	698	088	033	965	349	818	26
35	720	070	055	946	371	799	25
36	742	051	077	927	393	780	24
37	765	033	099	908	414	760	23
38	787	014	122	889	436	741	22
39	810	76996	144	870	458	722	21
40	832	977	166	851	480	703	20
41	854	959	188	832	501	683	19
42	877	940	210	813	523	664	18
43	899	921	232	794	545	644	17
44	922	903	254	775	566	625	16
45	944	884	276	756	588	606	15
46	63966	76866	65298	75738	66610	74586	14
47	989	847	320	719	632	567	13
48	64011	828	342	699	653	548	12
49	033	810	364	680	675	528	11
50	056	791	386	661	697	509	10
51	078	772	408	642	718	489	9
52	100	754	430	623	740	470	8
53	123	735	452	604	762	451	7
54	145	717	474	585	783	431	6
55	167	698	496	566	805	412	5
56	190	679	518	547	827	392	4
57	212	661	540	528	848	373	3
58	234	642	562	509	870	353	2
59	256	623	584	490	891	334	1
M	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S	N. S.	M
	50 Deg.		49 Deg.		48 Deg.		

M	42 Deg.		43 Deg.		44 Deg.		M
	N. S.	N.C.S	N. S.	N.C.S.	N. S.	N.C.S.	
0	66913	74314	68200	73135	69466	71934	60
1	935	295	221	116	487	914	59
2	956	276	242	096	508	894	58
3	978	256	264	076	529	873	57
4	999	237	285	056	549	853	56
5	67021	217	306	036	570	833	55
6	043	198	327	016	591	813	54
7	064	178	349	72996	612	792	53
8	086	159	370	976	633	772	52
9	107	139	391	957	654	752	51
10	129	120	412	937	675	732	50
11	151	100	433	917	696	711	49
12	172	080	455	897	717	691	48
13	194	061	476	877	737	671	47
14	215	041	497	857	758	650	46
15	237	022	518	837	779	630	45
M	N.C.S.	N. S.	N.C.S.	N. S.	N.C.S.	N. S.	M
	47 Deg.		46 Deg.		45 Deg.		

	42 Deg.		43 Deg.		44 Deg.		
M	Nat. Sine	N. Co-Sine	Nat. Sine.	N. Co-Sine.	Nat. Sine.	N. Co-Sine	M
16	67258	74002	68539	72817	69800	71610	44
17	280	73983	561	797	821	590	43
18	301	963	582	777	842	569	42
19	323	944	603	757	862	549	41
20	344	924	624	737	883	529	40
21	366	904	645	717	904	508	39
22	387	885	666	697	925	488	38
23	409	865	688	677	946	468	37
24	430	846	709	657	966	447	36
25	452	826	730	637	987	427	35
26	473	806	751	617	70008	407	34
27	495	787	772	597	029	386	33
28	516	767	793	577	049	366	32
29	538	747	814	557	070	345	31
30	559	728	835	537	091	325	30
31	67580	73708	68857	72517	70112	71305	29
32	602	688	878	497	132	284	28
33	623	669	899	477	153	264	27
34	645	649	920	457	174	243	26
35	666	629	941	437	195	223	25
36	688	610	962	417	215	203	24
37	709	590	983	397	236	182	23
38	730	570	69004	377	257	162	22
39	752	551	025	357	277	141	21
40	773	531	046	337	298	121	20
41	795	511	067	317	319	100	19
42	816	491	088	297	339	080	18
43	837	472	109	277	360	059	17
44	859	452	130	257	381	039	16
45	880	432	151	236	401	019	15
46	67901	73412	69172	72216	70422	70998	14
47	923	393	193	196	443	978	13
48	944	373	214	176	463	957	12
49	965	353	235	156	484	937	11
50	987	333	256	136	505	916	10
51	68008	314	277	116	525	896	9
52	029	294	298	095	546	875	8
53	051	274	319	075	567	855	7
54	072	254	340	055	587	834	6
55	093	234	361	035	608	813	5
56	115	215	382	015	628	793	4
57	136	195	403	71995	649	772	3
58	157	175	424	974	670	752	2
59	179	155	445	954	690	731	1
60	200	135	466	934	711	711	0
M	N. Co-Sine.	Nat. Sine.	N. Co-Sine	Nat. Sine	N. Co-Sine	Nat. Sine	M
	47 Deg.		46 Deg.		45 Deg.		

III. *A Table of Logarithms for Numbers ; and*
IV. *A Table of Logarithmic or Artificial Sines, Tangents and Secants.*

Explanation of the Table of Logarithms for Numbers.

Logarithms are Numbers in Arithmetical Progression, corresponding to other Numbers in Geometrical Proportion. As,

0.	1.	2..	3.	4.	Logarithms.
1.	10.	100.	1000.	10000.	Numbers.

The Logarithm for any Number less than 10 is a certain number of Decimals ; for any number between 10 and 100 it is 1 with Decimals ; for any Number between 100 and 1000 it is 2 with Decimals, &c. The whole Number in Logarithms, or the Number which stands at the Left hand of the Decimal Point is called the Index ; and is always a Unit less than the places of figures in the whole Number for which it is the Logarithm : Thus,

The Log. of 6543 - is - 3.81578
654.3 - - 2.81578
65.43 - - 1.81578
6.543 - - 0.81578

The Log. of a Decimal Fraction is the same as that of an Integer, only the Index is negative ; and is distinguished from an absolute one by placing a Point or a negative Sign before it : Thus,

The Log. of 0.6543 - is - .9.81578 or — 1.81578
0.06543 - - .8.81578 or — 2.81578

By the following Table the Log. of any Number, containing three places of figures, whether whole Numbers, mixed Numbers or Decimals, may be found true at once.

Look for the two first figures in the Left or Right hand Column, marked No. and for the third figure on the Top of the Page ; against the two first figures and under the third will be the Logarithm.

Examples.

Required the Logarithm for 346

Look for 34 in the Column marked No. and for 6 on the Top of the Page, under which and against 34 you find 53908 to which prefix 2 for the Index, because the Number consists of three places of figures

In the same way the Log. for 28.3 will be found to be 1.45179

And the Log. for 3.23 to be 0.50920

To find the Number corresponding to any Logarithm.

Look in the Table till you find the given Log. without regarding the Index ; the Number standing against it in the Column marked No. together with the figure on the Top, form the corresponding Number ; whether whole, mixed or Decimals, will be determined by the Index. If you cannot find the exact Log. take the nearest to it.

If the Log. of any Number between 10 and 100, with two places of Decimals, be required, take the nearest number of tenths, which will be sufficiently exact for common practice. But, if great accuracy be desired, work by Natural Sines, in the manner pointed out in Trigonometry, and in the Introduction to the Table of Natural Sines. Or,

The Log. of any Number containing more than three places of figures, may be found by the Table in this Book, as follows :

Find the Log. of the three first figures as before taught ; subtract that from the next greater Log. contained in the Table; multiply the difference by the remaining figure or figures in the given Number, and from the Product cut off as many figures from the Right hand as remain in the given Number; add the figure or figures standing at the Left hand to the Log. of the three first figures, and the Sum will be the Log. required, to which prefix the proper Index.

EXAMPLES.

1. *Required the Logarithm of* 7624

Log. of 763 - - .88252
762 - - .88195
Difference - - - 57
Remaining figure - 4
22.8
Log. of 762 - 88195
Required Log. 3.88217

Note. This is also the Log. of 762.4 or 76.24, &c. varying the Index according to the preceding directions.

2. *Required the Logarithm of* 541.25

Log. of 542 - - .73400
541 - - .73320
Difference - - 80
Remaining figures of the given Numb. 25
400
160
20.00
Log. of 541 - - .73320
Required Log. - 2.73340

To find the nearest Number corresponding to any Logarithm for more than three places of figures.

Find the Log. next less than the given one, and take the difference between that and the given one; also take the difference between the next greater and the next less Log. than the given one; divide the former difference by the latter, according to the Rule in Divison of Decimals; add the Quotient to the number answering to the Log. next less than the given one, and you will have the required Number; whether a whole or a mixed Number will be determined by the Index.

EXAMPLES.

1. *Required the Number to the Logarithm* 3.88218

Given Log. - .88218 Next greater Log. - .88252
Next less - .88195 Next less - - - - .88195
Difference - 23 Difference - - 57

57)23.0(4
228
2

The Number [illegible] next less than the given one is 762 because [illegible] makes 7624 the required Number.

2. [illegible] 2.7334

Given Log. [illegible] [illegible] .7340

Next less [illegible] [illegible] .7332

Difference [illegible] Difference [illegible]

[illegible]

The Number [illegible] Number will be [illegible]

The [illegible] Number [illegible] their Sum [illegible] the Log. of [illegible] er Number [illegible] one of [illegible] any Number [illegible] that Number [illegible] of the Square [illegible]

[illegible]

The [illegible] rithms [illegible] and [illegible] common cases [illegible] many Mathematical [illegible] mental [illegible]

Let a = greater } number to be added or subtracted.
b = lesser }

Then $\frac{a}{b} + 1 \times b = a + b$

And $\frac{a}{b} - 1 \times b = a - b$

These Theorems may be expressed in words as follows. From the Log. of the greater number subtract the Log. of the lesser, and find the number corresponding to the Remainder. Then if the original numbers are to be added together add 1 to the number last found; but if they are to be subtracted, subtract 1 from it; and the Log. of the number thus increased or diminished, added to the Log. of the lesser original number, will give the Log. of the Sum or Difference required.

that from the next greater Log. contained in the Table; mul- the difference by the remaining figure or figures in the given mber, and from the Product cut off as many figures from the ght hand as remain in the given Number; add the figure or ures standing at the Left hand to the Log. of the three first ures, and the Sum will be the Log. required, to which prefix e proper Index.

EXAMPLES.

1. *Required the Logarithm of* 7624

Log. of 763 - - .88252
762 - - .88195

Difference - - - 57
Remaining figure - 4

22.8

Log. of 762 - 88195

Required Log. 3.88217

Note. This is also the Log. of 762.4 or 76.24, &c. varying the Index according to the preceding directions.

2. *Required the Logarithm of* 541.25

Log. of 542 - - .73400
541 - - .73320

Difference - - 80
Remaining figures of the given Numb. 25

400
160

20.00

Log. of 541 - - .73320

Required Log. - 2.73340

To find the nearest Number corresponding to any Logarithm for more than three places of figures.

Find the Log. next less than the given one, and take the difference between that and the given one; also take the difference between the next greater and the next less Log. than the given one; divide the former difference by the latter, according to the Rule in Divison of Decimals; add the Quotient to the number answering to the Log. next less than the given one, and you will have the required Number; whether a whole or a mixed Number will be determined by the Index.

EXAMPLES.

1. *Required the Number to the Logarithm* 3.88218

Given Log. - .88218
Next less - .88195

Difference - 23

Next greater Log. - - - .88252
Next less - - - - .88195

Difference - - 5

57)23.0(4
228

2

Of the TABLE *of* LOGARITHMIC *or* ARTIFICIAL SINES, TANGENTS *and* SECANTS.

To find the Logarithmic Sine, &c. *for any number of Degrees and Minutes, within the Compass of the Table.*

If the Degrees be less than 45, look for them at the top of the Columns, and under Sine, Tangent or Secant, whichever is wanted, and for the Minutes at the left hand; but if more than 45, look for the Degrees at the Bottom over Sine, &c. and for the Minutes at the Right hand; under or over the Degrees and against the Minutes will be the required Log. Sine, &c.

To find the Degrees and Minutes corresponding to a given Logarithmic Sine, &c.

Look in the proper Column for the nearest Log. to the given one; and the degrees and Minutes standing over or under and against it, are those required.

Note, When the Log. Sine, &c. for more than 90° is required, subtract the given number of Degrees from 180° and make use of the Remainder.

It will be observed that this Table is calculated only for every 5 Minutes. This was thought sufficient for Surveyors, as few Compasses will take a Course to greater exactness. If however a Question is to be solved where greater accuracy is required, work by natural Sines. Or,

The Log. Sine, &c. *for any Minute may be found as follows:*

Look in the Table for the Log. of the nearest number of Minutes greater than the given one, and from this substract the next less Log. contained in the Table: Then say, As 5 Minutes, Is to this difference; So is the excess of the given Minutes above 5, 10, 15, 20, 25, &c; To a fourth number, which add to the Log. of the Minutes next less than the given number, and the sum will be the Log. required.

EXAMPLE.

Required the Logarithmic Sine of 34° 23′

Sine of 34° 25′	- -	9.75221
34 20	- -	9.75128
Difference		93

As 5 : 93 : : 3 : 56

Sine of 34° 20′	- -	9.75128
Add	- - -	56
Sine of 34° 23′	- -	9.75184

To find the nearest Minutes corresponding to a given Logarithmic Sine, &c.

Look in the Table, in the proper Column, for the Log. next less than the given one, and take the difference between that and the given one; also take the difference between the next greater and the next less Log. than the given one; Then say, As the latter difference; Is to 5 Minutes; So is the former difference; To the number of Minutes to be added to the Minutes of the Log. next less than the given one.

EXAMPLE.

Required the Degrees and Minutes corresponding to the Logarithmic Tangent 9.73597.

Given Log. -	9.73597	Next greater Log. -	9.73627
Next less -	9.73476	Next less - - - -	9.73476
Difference	121	Difference	151

As 151 : 5 :: 121 : 4

The Degrees and Minutes for the Log. next less than the given one are 28° 30′, to which add 4′ and it makes 28° 34′

Note. As after the most careful attention of the Printers, some figures in the Table may be wrong; and as some may be so blurred as to be illegible, let it be observed, that the Sines and Co-Secants, the Co-Sines and Secants, and the Tangents and Co-Tangents, standing against each other respectively, being added together, will amount to 20.00000, if the Tables are accurate. Thus against 28° 20′ the Sine 9.67633 added to the Co-Secant 10.32367 their Sum is 20.00000; so also is the Sum of the Co-Sine 9.94458 and the Secant 10.05542, and likewise the sum of the Tangent 9.73175 and the Co-Tangent 10.26825. An error may consequently be easily detected, or any defaced figure be supplied.

To calculate the Northing or Southing, &c. *for any Course and Distance by Logarithms.*

This is done by the first CASE of RIGHT ANGLED TRIGONOMETRY, as follows:

Find the Log. Sine and Co-Sine of the Course; to each of these add the Log. of the Distance; subtract Radius or 10.00000 from their Sums, and the Remainders will be the Log. of the required Latitude and Departure.

Note. When the Angle is very small or very large, and the Distance short, the sum of the Log. Sine or Co-Sine and the Log. of the Distance may be less than 10.00000 or Radius, which cannot therefore be subtracted. In such cases look for the Log. without regard to the Index, and the corresponding Number will be a Decimal, the first Figure of which will be Tenths if the Index be 9, and Hundredths if the Index be 8.

No	0	1	2	3	4	No
1	0.00000	0.04139	0.07918	0.11394	0.14613	1
2	30103	32222	34242	36173	38021	2
3	47712	49136	50515	51851	53148	3
4	60206	61278	62325	63347	64345	4
5	69897	70757	71600	72428	73239	5
6	77815	78533	79239	79934	80618	6
7	84510	85126	85733	86332	86923	7
8	90309	90849	91381	91908	92428	8
9	95424	95904	96379	96848	97313	9
10	1.00000	1.00432	1,00860	1.01284	1.01703	10
11	1.04139	1.04532	1.04922	1.05308	1.05690	11
12	07918	08279	08636	08991	09342	12
13	11394	11727	12057	12385	12710	13
14	14613	14922	15229	15534	15836	14
15	17609	17898	18184	18469	18752	15
16	20412	20683	20951	21219	21484	16
17	23045	23300	23553	23805	24055	17
18	25527	25768	26007	26245	26482	18
19	27875	28103	28330	28556	28780	19
20	30103	30320	30535	30750	30963	20
21	1.32222	1.32428	1.32634	1.32838	1.33041	21
22	34242	34439	34635	34830	35025	22
23	36173	36361	36549	36736	36922	23
24	38021	38202	38382	38561	38739	24
25	39794	39967	40140	40312	40483	25
26	41497	41664	41830	41996	42160	26
27	43136	43297	43457	43616	43775	27
28	44716	44871	45025	45179	45332	28
29	46240	46389	46538	46687	46835	29
30	47712	47857	48001	48144	48287	30
31	1.49136	1.49276	1.49415	1.49554	1.49693	31
32	50515	50650	50786	50920	51054	32
33	51851	51983	52114	52244	52375	33
34	53148	53275	53403	53529	53656	34
35	54407	54531	54654	54777	54900	35
36	55630	55751	55871	55991	56110	36
37	56820	56937	57054	57171	57287	37
38	57978	58092	58206	58320	58433	38
39	59106	59218	59329	59439	59550	39
40	60206	60314	60423	60530	60638	40
41	1.61278	1.61384	1.61490	1.61595	1.61700	41
42	62325	62428	62531	62634	62737	42
43	63347	63448	63548	63649	63749	43
44	64345	64444	64542	64640	64738	44
45	65321	65418	65514	65610	65706	45
46	66276	66370	66464	66558	66652	46
47	67210	67302	67394	67486	67578	47
48	68124	68215	68305	68395	68484	48
49	69020	69108	69197	69285	69373	49
50	69897	69981	70070	70157	70242	50

No	5	6	7	8	9	No
1	0.17609	0.20412	0.23045	0.25527	0.27875	1
2	39794	41497	43136	44716	46240	2
3	54407	55630	56820	57978	59106	3
4	65321	66276	67210	68124	69020	4
5	74036	74819	75587	76343	77085	5
6	81291	81954	82607	83251	83885	6
7	87506	88081	88649	89209	89763	7
8	92942	93450	93952	94448	94939	8
9	97772	98227	98677	99123	99564	9
10	1.02119	1.02531	1.02938	1.03342	1.03743	10
11	1.06070	1.06446	1.06819	1.07188	1.07555	11
12	09691	10037	10380	10721	11059	12
13	13033	13354	13672	13988	14302	13
14	16137	16435	16732	17026	17319	14
15	19033	19312	19590	19866	20140	15
16	21748	22011	22272	22531	22789	16
17	24304	24551	24797	25042	25285	17
18	26717	26951	27184	27416	27646	18
19	29003	29226	29447	29667	29885	19
20	31175	31387	31597	31806	32015	20
21	1.33244	1.33445	1.33646	1.33846	1.34044	21
22	35218	35411	35603	35793	35984	22
23	37107	37291	37475	37658	37840	23
24	38917	39093	39270	39445	39620	24
25	40654	40824	40993	41162	41330	25
26	42325	42488	42651	42813	42975	26
27	43933	44091	44248	44404	44560	27
28	45484	45637	45788	45939	46090	28
29	46982	47129	47276	47422	47567	29
30	48480	48572	48714	48855	48996	30
31	1.49831	1.49969	1.50106	1.50243	1.50379	31
32	51188	51322	51455	51587	51720	32
33	52504	52634	52763	52892	53020	33
34	53782	53908	54033	54158	54283	34
35	55023	55145	55267	55388	55509	35
36	56229	56348	56467	56585	56703	36
37	57403	57519	57634	57749	57864	37
38	58546	58659	58771	58883	58995	38
39	59660	59770	59879	59988	60097	39
40	60746	60853	60959	61066	61172	40
41	1.61805	1.61909	1.62014	1.62118	1.62221	41
42	62839	62941	63043	63144	63246	42
43	63849	63949	64048	64147	64246	43
44	64836	64933	65031	65128	65225	44
45	65801	65896	65992	66087	66181	45
46	66745	66839	66932	67025	67117	46
47	67669	67761	67852	67943	68034	47
48	68574	68664	68753	68842	68931	48
49	69461	69548	69636	69723	69810	49
50	70329	70415	70501	70586	70672	50

No	0	1	2	3	4	No
51	1.70757	1.70842	1.70927	1.71012	1.71096	51
52	71600	71684	71767	71850	71933	52
53	72428	72509	72591	72673	72754	53
54	73239	73320	73400	73480	73560	54
55	74036	74115	74194	74273	74351	55
56	74819	74896	74974	75051	75128	56
57	75587	75664	75740	75815	75891	57
58	76343	76418	76492	76567	76641	58
59	77085	77159	77232	77305	77379	59
60	77815	77887	77960	78032	78104	60
61	1.78533	1.78604	1.78675	1.78746	1.78817	61
62	79239	79309	79379	79449	79518	62
63	79934	80003	80072	80140	80209	63
64	80618	80686	80754	80821	80889	64
65	81291	81358	81425	81491	81558	65
66	81954	82020	82086	82151	82217	66
67	82607	82672	82737	82802	82866	67
68	83251	83315	83378	83442	83506	68
69	83885	83948	84011	84073	84136	69
70	84510	84572	84634	84696	84757	70
71	1.85126	1.85187	1.85248	1.85309	1.85370	71
72	85733	85794	85854	85914	85974	72
73	86332	86392	86451	86510	86570	73
74	86923	86982	87040	87099	87157	74
75	87506	87564	87622	87679	87737	75
76	88081	88138	88195	88252	88309	76
77	88649	88705	88762	88818	88874	77
78	89209	89265	89321	89376	89432	78
79	89763	89818	89873	89927	89982	79
80	90309	90363	90417	90472	90526	80
81	1.90849	1.90902	1.90956	1.91009	1.91062	81
82	91381	91434	91487	91540	91593	82
83	91908	91960	92012	92065	92117	83
84	92428	92480	92531	92583	92634	84
85	92942	92993	93044	93095	93146	85
86	93450	93500	93551	93601	93651	86
87	93952	94002	94052	94101	94151	87
88	94448	94498	94547	94596	94645	88
89	94939	94988	95036	95085	95134	89
90	95424	95472	95521	95569	95617	90
91	1.95904	1.95952	1.95999	1.96047	1.96095	91
92	96379	96426	96473	96520	96567	92
93	96848	96895	96942	96988	97035	93
94	97313	97359	97405	97451	97497	94
95	97772	97818	97864	97909	97955	95
96	98227	98272	98318	98363	98408	96
97	98677	98722	98767	98811	98856	97
98	99123	99167	99211	99255	99300	98
99	99564	99607	99651	99695	99739	99
100	2.00000	2.00043	2.00087	2.00130	2.00173	100

No.	5	6	7	8	9	No
51	1.71181	1.71265	1.71349	1.71433	1.71517	51
52	72016	72099	72181	72263	72346	52
53	72835	72916	72997	73078	73159	53
54	73640	73719	73799	73878	73957	54
55	74429	74507	74586	74663	74741	55
56	75205	75282	75358	75435	75511	56
57	75967	76042	76118	76193	76268	57
58	76716	76790	76864	76938	77012	58
59	77452	77525	77597	77670	77743	59
60	78176	78247	78319	78390	78462	60
61	1.78888	1.78958	1.79029	1.79099	1.79169	61
62	79588	79657	79727	79796	79865	62
63	80277	80346	80414	80482	80550	63
64	80956	81023	81090	81158	81224	64
65	81624	81690	81757	81823	81889	65
66	82282	82347	82413	82478	82543	66
67	82930	82995	83059	83123	83187	67
68	83569	83632	83696	83759	83822	68
69	84198	84261	84323	84386	84448	69
70	84819	84880	84942	85003	85065	70
71	1.85431	1.85491	1.85552	1.85612	1.85673	71
72	86034	86094	86153	86213	86273	72
73	86629	86688	86747	86806	86864	73
74	87216	87274	87332	87390	87448	74
75	87795	87852	87910	87967	88024	75
76	88366	88423	88480	88536	88593	76
77	88930	88986	89042	89098	89154	77
78	89487	89542	89597	89653	89708	78
79	90037	90091	90146	90200	90255	79
80	90580	90634	90687	90741	90795	80
81	1.91116	1.91169	1.91222	1.91275	1.91328	81
82	91645	91698	91751	91803	91855	82
83	92169	92221	92273	92324	92376	83
84	92686	92737	92788	92840	92891	84
85	93197	93247	93298	93349	93399	85
86	93702	93752	93802	93852	93902	86
87	94201	94250	94300	94349	94399	87
88	94694	94743	94792	94841	94890	88
89	95182	95231	95279	95328	95376	89
90	95665	95713	95761	95809	95856	90
91	1.96142	1.96190	1.96237	1.96284	1.96332	91
92	96614	96661	96708	96755	96802	92
93	97081	97128	97174	97220	97267	93
94	97543	97589	97635	97681	97727	94
95	98000	98046	98091	98137	98182	95
96	98453	98498	98543	98588	98632	96
97	98900	98945	98989	99034	99078	97
98	99344	99388	99432	99476	99520	98
99	99782	99826	99870	99913	99957	99
100	2.00217	2.00260	2.00303	2.00346	2.00389	100

0 Degree.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	C. Secant
0	0.00000	10.00000	0.00000	Infinite	10.00000	Infinite
5	7.16270	00	7.16270	12.83730	00	12.83730
10	46373	00	46373	53627	00	53627
15	63982	00	63982	36018	00	36018
20	76475	9.99999	76476	23524	01	23525
25	86166	99	86167	13833	01	13834
30	94084	98	94086	05914	02	05915
35	8.00779	9.99998	8.00781	11.99219	10.00002	11.99221
40	06578	97	06581	93419	03	93422
45	11693	96	11696	88304	04	88307
50	16268	95	16273	83727	05	83732
55	20407	94	20413	79587	06	79593
60	24186	93	24192	75808	07	75814
M	Co-Sine	Sine	C. Tang.	Tangent	C. Secan	Secant

89 Degrees.

1 Degree.

M	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant
0	8.24186	9.99993	8.24192	11.75808	10.00007	11.75814
5	27661	92	27669	72331	08	72339
10	30879	91	30888	69112	09	6912
15	33875	89	33886	66114	11	6612
20	36678	88	36689	63311	12	6332
25	39310	87	39323	60677	13	6069
30	41792	85	41807	58193	15	5820
35	8.44139	9.99983	8.44156	11.5584	10.00017	11.5586
40	46366	82	46385	53615	18	5363
45	48485	80	48505	51495	20	5151
50	50505	78	50527	49473	22	4949
55	52434	76	52459	47541	24	4756
60	54282	74	54308	45692	26	4571
M	Co-Sine	Sine	C. Tang	Tangent	C. Secant	Secant

88 Degrees.

2 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant.	Co-Seca
0	8.54282	9.99974	8.54308	11.45692	10.00026	11.4571
5	56054	71	56083	43917	29	4394
10	57757	69	57788	42212	31	4224
15	59395	66	59428	40572	34	4060
20	60973	64	61009	38991	36	3902
25	62496	61	62535	37465	39	3750
30	63968	59	64009	35991	41	3603
35	8.65391	9.99956	8.65435	11.34565	10.00044	11.3460
40	66769	53	66816	33184	47	3323
45	68104	50	68154	31846	50	3189
50	69400	47	69453	30547	53	3060
55	70658	44	70714	29286	56	2934
60	71880	40	71940	28060	60	2812
M.	Co-Sine	Sine	C. Tang	Tangent	Co-Secant	Secant

87 Degrees.

3 Degrees.

Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
8.71880	9.99940	8.71940	11.28060	10.00060	11.28120	60
73069	37	73132	26868	63	26931	55
74226	34	74292	25708	66	25774	50
75353	30	75423	24577	70	24647	45
76451	26	76525	23475	74	23549	40
77522	23	77600	22400	77	22478	35
78567	19	78649	21351	81	21433	30
8.79588	9.99915	8.79673	11.20327	10.00085	11.20412	25
80585	11	80674	19326	89	19415	20
81560	07	81653	18347	93	18440	15
82513	03	82610	17390	97	17487	10
83446	99898	83547	16453	102	16554	5
84358	894	84464	15536	106	15642	0
Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

86 Degrees.

4 Degrees.

Sine	Co-Sine	Tangent	C. Tang	Secant	Co-Secant	M.
8.84358	9.99894	8.84464	11.15536	10.00106	11.15642	60
85252	890	85363	14637	110	14748	55
86128	885	86243	13757	115	13872	50
86987	880	87106	12894	120	13013	45
87829	876	87953	12047	124	12171	40
88654	871	88783	11217	129	11346	35
89464	866	89598	10402	134	10536	30
8.90260	9.99861	8.90399	11.09601	10.00139	11.09740	25
91040	856	91185	08815	144	08960	20
91807	851	91957	08043	149	08193	15
92561	845	92716	07284	155	07439	10
93302	840	93462	06538	160	06698	5
94030	834	94195	05805	166	05970	0
Co-Sine	Sine	C Tang.	Tangent	Co-Secant	Secant	M.

85 Degrees.

5 Degrees.

Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M
8.94030	9.99834	8.94195	11.05805	10.00166	11.05970	60
94746	829	94917	05083	171	05254	55
95450	823	95627	04373	177	04550	50
96143	817	96325	03675	183	03857	45
96825	812	97013	02987	188	03175	40
97496	806	97691	02309	194	02504	35
98157	800	98358	01642	200	01843	30
8.98808	9.99794	8.99015	11.00985	10.00206	11.01192	25
99450	787	99662	00338	213	00550	20
9.00082	781	9.00301	10.99699	219	10.99918	15
00704	775	00930	99070	225	99296	10
01318	768	01550	98450	232	98682	5
01923	761	02162	97838	239	98077	0
Co. Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

84 Degrees.

6 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M
0	9.01924	9.99761	9.02162	10.97838	10.00239	10.98076	60
5	02520	755	02765	97235	245	97480	55
10	03109	748	03361	96639	252	96891	50
15	03690	741	03949	96051	259	96310	45
20	04263	734	04528	95472	266	95737	40
25	04828	727	05101	94899	273	95172	35
30	05386	720	05666	94334	280	94614	30
35	9.05937	9.99713	9.06224	10.93776	10.00287	10.94063	25
40	06481	705	06775	93225	295	93519	20
45	07018	698	07320	92680	302	92982	15
50	07546	690	07858	92142	310	92452	10
55	08072	683	08389	91611	317	91928	5
60	08589	675	08914	91086	325	91411	0
M	Co-Sine	Sine	C. Tang	Tangent	Co-Secant	Secant	M.

83 Deg.

7 Deg

M	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M
0	9.08589	9.99675	9.08914	10.91086	10.00325	10.91411	60
5	09101	667	09434	90566	333	90899	55
10	09606	659	09947	90053	341	90394	50
15	10106	651	10454	89546	349	89894	45
20	10599	643	10956	89044	357	89401	40
25	11087	635	11452	88548	365	88913	35
30	11570	627	11943	88057	373	88430	30
35	9.12047	9.99618	9.12428	10.87572	10.00382	10.87953	25
40	12519	610	12909	87091	390	87481	20
45	12985	602	13384	86616	398	87015	15
50	13447	593	13854	86146	407	86553	10
55	13904	584	14320	85680	416	86096	5
60	14356	575	14780	85220	425	85644	0
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

82 Degrees.

8 Degrees.

M	Sine	Co-Sine.	Tangent	C. Tang.	Secant	Co-Secant	M.
0	9.14356	9.99575	9.14780	10.85220	10.00425	10.85644	60
5	14803	566	15236	84764	434	85197	55
10	15245	557	15688	84312	443	84755	50
15	15683	548	16135	83865	452	84317	45
20	16116	539	16577	83423	461	83884	40
25	16545	530	17016	82984	470	83455	35
30	16970	520	17450	82550	480	83030	30
35	9.17391	9.99511	9.17880	10.82120	10.00489	10.82609	25
40	17807	501	18306	81694	499	82193	20
45	18220	492	18728	81272	508	81780	15
50	18628	482	19146	80854	518	81372	10
55	19033	472	19561	80439	528	80967	5
60	19433	462	19971	80029	538	80567	0
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

81 Degrees.

9 Degrees

Sine	Co-Sine	Tangent	C. Tang	Secant	Co-Secant	M.
9.19433	9.99462	9.19971	10.80029	10.00538	10.80567	60
19830	452	20378	79622	548	80170	55
20223	442	20782	79218	558	79777	50
20613	432	21182	78818	568	79387	45
20999	421	21578	78422	579	79001	40
21382	411	21971	78029	589	78618	35
21761	400	22361	77639	600	78239	30
9.22137	9.99390	9.22747	10.77253	10.00610	10.77863	25
22509	379	23130	76870	621	77491	20
22878	368	23510	76490	632	77122	15
23244	357	23887	76113	643	76756	10
23607	346	24261	75739	654	56393	5
23967	335	24632	75368	665	76033	0
Co.Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

80 Degrees.

10 Degrees.

Sine	Co-Sine	Tangent	C. Tang	Secant	Co-Secant	M.
9.23967	9.99335	9.24632	10.75368	10.00665	10.76033	60
24324	324	25000	75000	676	75676	55
24677	313	25365	74635	687	75323	50
25028	301	25727	74273	699	74972	45
25376	290	26086	73914	710	74624	40
25721	278	26443	73557	722	74279	35
26063	267	26797	73203	733	73937	30
9.26403	9.99255	9.27148	10.72852	10.00745	10.73597	25
26739	243	27496	72504	757	73261	20
27073	231	27842	72158	769	72927	15
27405	219	28186	71814	781	72595	10
27734	207	28527	71473	793	72266	5
28060	195	28865	71135	805	71940	0
Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

79 Degrees.

11 Degrees.

Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
9.28060	9.99195	9.28865	10.71135	10.00805	10.71940	60
28384	182	29201	70799	818	71616	55
28705	170	29535	70465	830	71295	50
29024	157	29866	70134	843	70976	45
29340	145	30195	69805	855	70660	40
29654	132	30522	69478	868	70346	35
29966	119	30846	69154	881	70034	30
9.30275	9.99106	9.31168	10.68832	10.00894	10.69725	25
30582	093	31489	68511	907	69418	20
30887	080	31806	68194	920	69113	15
31189	067	32122	67878	933	68811	10
31490	054	32436	67564	946	68510	5
31788	040	32748	67252	960	68212	0
Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

78 Degrees.

12 Degrees.

M	Sine	Co-Sine	Tangent	C. Tang	Secant	Co-Secant	M
0	9.31788	9.99040	9.32747	10.67253	10.00960	10.68212	60
5	32084	99027	33057	66943	00973	67916	55
10	32378	99013	33365	66635	00987	67622	50
15	32670	99000	33670	66330	01000	67330	45
20	32960	98986	33974	66026	01014	67040	40
25	33248	98972	34276	65724	01028	66752	35
30	33534	98958	34576	65424	01042	66466	30
35	9.33818	9.98944	9.34874	10.65126	10.01056	10.66182	25
40	34100	98930	35170	64830	01070	65900	20
45	34380	98916	35464	64536	01084	65620	15
50	34658	98901	35757	64243	01099	65342	10
55	34934	98887	36047	63953	01113	65066	5
60	34209	98872	36336	63664	01128	64791	0
M	Co-Sine	Sine	C. Tang	Tangent	Co-Secant	Secant	M.

77 Degrees.

13 Dgrees.

M.	Sine	Co-Sine	Tangent	C.Tang.	Secant	Co-Secant	M.
0	9.35209	9.98872	9.36336	10.63664	10.01128	10.64791	60
5	35482	98858	36624	63376	01142	64518	55
10	35752	98843	36909	63091	01157	64248	50
15	36022	98828	37193	62807	01172	63978	45
20	36289	98813	37476	62524	01187	63711	40
25	36555	98798	37756	62244	01202	63445	35
30	36818	98783	38035	61965	01217	63182	30
35	9.37081	9.98768	9.38313	10.61687	10.01232	10.62919	25
40	37341	98753	38589	61411	01247	62659	20
45	37600	98737	38863	61137	01263	62400	15
50	37858	98722	39136	60864	01278	62142	10
55	38113	98706	39407	60593	01294	61887	5
60	38368	98690	39677	60323	01310	61632	0
M	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

76 Degrees.

14 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
0	9.38368	9.98690	9.39677	10.60323	10.1310	10.61632	60
5	38620	98675	39945	60055	01325	61380	55
10	38871	98659	40212	59788	01341	61129	50
15	39121	98643	40478	59522	01357	60875	45
20	39369	98627	40742	59258	01373	60631	40
25	39615	98610	41004	58996	01390	60385	35
30	39860	98594	41266	58734	01406	60140	30
35	9.40104	9.98578	9.41526	10.58474	10.1422	10.59896	25
40	40345	98561	41784	58216	01439	59655	20
45	40586	98545	42042	57958	01455	59414	15
50	40825	98528	42297	57703	01472	59175	10
55	41063	98511	42552	57448	01489	58937	5
60	41300	98494	42805	57195	01506	58700	0
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

75 Degrees.

15 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M
0	9.41300	9.98494	9.42805	10.57195	10.01506	10.58700	60
5	41535	98477	43057	56943	01523	58465	55
10	41768	98460	43308	56692	01540	58232	50
15	42001	98443	43558	56442	01557	57999	45
20	42232	98426	43806	56194	01574	57768	40
25	42462	98409	44053	55947	01591	57538	35
30	42690	98391	44299	55701	01609	57310	30
35	9.42917	9.98374	9.44544	10.55456	10.01626	10.57083	25
40	43143	98356	44787	55213	01644	56857	20
45	43368	98338	45029	54971	01662	56632	15
50	43591	98320	45271	54729	01680	56409	10
55	43813	98302	45511	54489	01698	56187	5
60	44034	98284	45750	54250	01716	55966	0
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

74 Degrees.

16 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
0	9.44034	9.98284	9.45750	10.54250	10.01716	10.55966	60
5	44253	98266	45987	54013	01734	55747	55
10	44472	98248	46224	53776	01752	55528	50
15	44689	98229	46460	53540	01771	55311	45
20	44905	98211	46694	53306	01789	55095	40
25	45120	98192	46928	53072	01808	54880	35
30	45334	98174	47160	52840	01826	54666	30
35	9.45547	9.98155	9.47392	10.52608	10.01845	10.54453	25
40	45758	98136	47622	52378	01864	54242	20
45	45969	98117	47852	52148	01883	54031	15
50	46178	98098	48080	51920	01902	53822	10
55	46386	98079	48307	51693	01921	53614	5
60	46594	98060	48534	51466	01940	53406	0
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M

73 Degrees.

17 Degrees.

M	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
0	9.46594	9.98060	9.48534	10.51466	10.01940	10.53406	60
5	46800	98040	48759	51241	01960	53200	55
10	47005	98021	48984	51016	01979	52995	50
15	47209	98001	49207	50793	01999	52791	45
20	47412	97982	49430	50570	02018	52588	40
25	47613	97962	49652	50348	02038	52387	35
30	47814	97942	49872	50128	02058	52186	30
35	9.48014	9.97922	9.50092	10.49908	10.02078	10.51986	25
40	48213	97902	50311	49689	02098	51787	20
45	48411	97882	50529	49471	02118	51589	15
50	48608	97861	50746	49254	02139	51392	10
55	48803	97841	50962	49038	02159	51197	5
60	48998	97821	51178	48822	02179	51002	0
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M

72 Degrees.

18 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
0	9.48998	9.97821	9.51178	10.48822	10.02179	10.51002	60
5	49192	97800	51392	48608	02200	50808	55
10	49385	97779	51606	48394	02221	50615	50
15	49577	97759	51819	48181	02241	50423	45
20	49768	97738	52031	47969	02262	50232	40
25	49958	97717	52242	47758	02283	50042	35
30	50148	97696	52452	47548	02304	49852	30
35	9.50336	9.97674	9.52661	10.47339	10.02326	10.49664	25
40	50523	97653	52870	47130	02347	49477	20
45	50710	97632	53078	46922	02368	49290	15
50	50896	97610	53285	46715	02390	49104	10
55	51080	97589	53492	46508	02411	48920	5
60	51264	97567	53697	46303	02433	48736	0
M	Co-Sine	Sine	C. Tang.	Tangent.	Co-Secant	Secant	M

71 Degrees.

19 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
0	9.51264	9.97567	9.53697	10.46303	10.02433	10.48736	60
5	51447	97545	53902	46098	02455	48553	55
10	51629	97523	54106	45894	02477	48371	50
15	51811	97501	54309	45691	02499	48189	45
20	51991	97479	54512	45488	02521	48009	40
25	52171	97457	54714	45286	02543	47829	35
30	52350	97435	54915	45085	02565	47650	30
35	9.52527	9.97412	9.55115	10.44885	10.02588	10.47473	25
40	52705	97390	55315	44685	02610	47295	20
45	52881	97367	55514	44486	02633	47119	15
50	53056	97344	55712	44288	02656	46944	10
55	53231	97322	55910	44090	02678	46769	5
60	53405	97299	56107	43893	02701	46595	0
M	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

70 Degrees.

20 Degrees.

M	Sine	Co-Sine	Tangent	C. Tang	Secant	Co-Secant	M
0	9.53405	9.97299	9.56107	10.43893	10.02701	10.46595	60
5	53578	97275	56303	43697	02725	46422	55
10	53751	97252	56498	43502	02748	46249	50
15	53922	97229	56693	43307	02771	46078	45
20	54093	97206	56887	43113	02794	45907	40
25	54263	97182	57081	42919	02818	45737	35
30	54433	97159	57274	42726	02841	45567	30
35	9.54601	9.97135	9.57466	10.42534	10.02865	10.45399	25
40	54769	97111	57658	42342	02889	45231	20
45	54936	97087	57849	42151	02913	45064	15
50	55102	97063	58039	41961	02937	44898	10
55	55268	97039	58229	41771	02961	44732	5
60	55433	97015	58418	41582	02985	44567	0
M	Co-Sine	Sine	C. Tang	Tangent	Co-Secant	Secant	M.

69 Degrees.

21 Degrees.

Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
9.55433	9.97015	9.58418	10.41582	10.02985	10.44567	60
55597	96991	58606	41394	03009	44403	55
55761	96966	58794	41206	03034	44239	50
55923	96942	58981	41019	03058	44077	45
56085	96917	59168	40832	03083	43915	40
56247	96893	59354	40646	03107	43753	35
56408	96868	59540	40460	03132	43592	30
9.56568	9.96843	9.59725	10.40275	10.03157	10.43432	25
56727	96818	59909	40091	03182	43273	20
56886	96793	60093	39907	03207	43114	15
57044	96767	60276	39724	03233	42956	10
57201	96742	60459	39541	03258	42799	5
57358	96717	60641	39359	03283	42642	0
Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

68 Degrees.

22 Degrees.

Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
9.57358	9.96717	9.60641	10.39359	10.03283	10.42642	60
57514	96691	60823	39177	03309	42485	55
57669	96665	61004	38996	03335	42331	50
57824	96640	61184	38816	03360	42176	45
57978	96614	61364	38636	03386	42022	40
58131	96588	61544	38456	03412	41869	35
58284	96562	61722	38278	03438	41716	30
9.58435	9.96535	9.61901	10.38099	10.03465	10.41564	25
58588	96509	62079	37921	03491	41412	20
58739	96483	62256	37744	03517	41261	15
58889	96456	62433	37567	03544	41111	10
59039	96429	62609	37391	03571	40961	5
59188	96403	62785	37215	03597	40812	0
Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

67 Degrees.

23 Degrees.

Sine	Co-Sine	Tangent	C. Tang	Secant	Co-Secant	M
9.59188	9.96403	9.62785	10.37215	10.03597	10.40812	60
59336	96376	62961	37039	03624	40664	55
59484	96349	63135	36865	03651	40516	50
59632	96322	63310	36690	03678	40368	45
59778	96294	63484	36516	03706	40222	40
59924	96267	63657	36343	03733	40076	35
60070	96240	63830	36170	03760	39930	30
9.60215	9.96212	9.64003	10.35997	10.03788	10.39785	25
60359	96185	64175	35825	03815	39641	20
60503	96157	64346	35654	03843	39497	15
60646	96129	64517	35483	03871	39354	10
60789	96101	64688	35312	03899	39211	5
60931	96073	64858	35142	03927	39069	0
Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

66 Degrees.

24 Degrees.

M.	Sine	Co.Sine	Tangent	C. Tang.	Secant	Co-Secant
0	9.60931	9.96073	9.64858	10.35142	10.03927	10.39069
5	61073	96045	65028	34972	03955	38927
10	61214	96017	65197	34803	03983	38786
15	61354	95988	65366	34634	04012	38646
20	61494	95960	65535	34465	04040	38506
25	61634	95931	65703	34297	04069	33366
30	61773	95902	65870	34130	04098	33227
35	9.61911	9.95873	9.66038	10.33962	10.04127	10.38089
40	62049	95844	66204	33796	04156	37951
45	62186	95815	66371	33629	04185	37814
50	62323	95786	66537	33463	04214	37677
55	62459	95757	66702	33298	04243	37541
60	62595	95728	66867	33133	04272	37405
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant

65 Degrees.

25 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant
0	9.62595	9.95728	9.66867	10.33133	10.04272	10.37405
5	62730	95698	67032	32968	04302	3727
10	62865	95668	67196	32804	04332	3713
15	62999	95639	67360	32640	04361	3700
20	63133	95609	67524	32476	04391	3686
25	63266	95579	67687	32313	04421	3673
30	63398	95549	67850	32150	04451	3660
35	9.63551	9.95519	9.68012	10.31988	10.04481	10.3646
40	63662	95488	68174	31826	04512	3633
45	63794	95458	68336	31664	04542	3620
50	63924	95427	68497	31503	04573	3607
55	64054	95397	68658	31342	04603	3594
60	64184	95366	68818	31182	04634	3581
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant

64 Degrees.

26 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant
0	9.64184	9.95366	9.68818	10.31182	10.04634	10.3581
5	64313	95335	68978	31022	04665	3568
10	64442	95304	69138	30862	04696	3555
15	64571	95273	69298	30702	04727	3542
20	64698	95242	69457	30543	04758	3530
25	64826	95211	69615	30385	04789	3517
30	64953	95179	69774	30226	04821	3504
35	9.65079	9.95148	9.69932	10.30068	10.04852	10.3492
40	65205	95116	70089	29911	04884	3479
45	65331	95084	70247	29753	04916	3466
50	65456	95052	70404	29596	04948	3454
55	65580	95020	70560	29440	04980	3442
60	65705	94988	70717	29283	05012	3429
M.	Co-Sine	Sine	C.Tang	Tangent	Co-Secant	Secant

63 Degrees.

27 Degrees.

Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
9.65705	9.94988	9.70717	10.29283	10.05012	10.34295	60
65828	94956	70873	29127	05044	34172	55
65952	94923	71028	28972	05077	34048	50
66075	94891	71184	28816	05109	33925	45
66197	94858	71339	28661	05142	33803	40
66319	94826	71493	28507	05174	33681	35
66441	94793	71648	28352	05207	33559	30
9.66562	9.94760	9.71802	10.28198	10.05240	10.33438	25
66682	94727	71955	28045	05273	33318	20
66803	94694	72109	27891	05306	33197	15
66922	94660	72262	27738	05340	33078	10
67042	94627	72415	27585	05373	32958	5
67161	94593	72567	27433	05407	32839	0
Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

62 Degrees.

28 Degrees.

Sine	Co-Sine	Tangent	C.Tang.	Secant	Co-Secant	M.
9.67161	9.94593	9.72567	10.27433	10.05407	10.32839	60
67280	94560	72720	27280	05440	32720	55
67398	94526	72872	27128	05474	32602	50
67515	94492	73023	26977	05508	32485	45
67633	94458	73175	26825	05542	32367	40
67750	94424	73326	26674	05576	32250	35
67866	94390	73476	26524	05610	32134	30
9.67982	9.94355	9.73627	10.26373	10.05645	10.32018	25
68098	94321	73777	26223	05679	31902	20
68213	94286	73927	26073	05714	31787	15
68328	94252	74077	25923	05748	31672	10
68443	94217	74226	25774	05783	31557	5
68557	94182	74375	25625	05818	31443	0
Co-Sine	Sine	C. Tang	Tangent	Co-Secant	Secant	M.

61 Degrees.

29 Degrees.

Sine	Co-Sine	Tangent	Co, Tang.	Secant	Co-Secant	M
9.68557	9.94182	9.74375	10.25625	10.05818	10.31443	60
68671	94147	74524	25476	05853	31329	55
68784	94112	74673	25327	05888	31216	50
68897	94076	74821	25179	05924	31103	45
69010	94041	74969	25031	05959	30990	40
69122	94005	75117	24883	05995	30878	35
69234	93970	75264	24736	06030	30766	30
9.69345	9.93934	9.75411	10.24589	10.06066	10.30655	25
69456	93898	75558	24442	06102	30544	20
69567	93862	75705	24295	06138	30433	15
69677	93826	75852	24148	06174	30323	10
69787	93789	75998	24002	06211	30213	5
69897	93753	76144	23856	06247	30103	0
Co-Sine	Sine	Co-Tang.	Tangent	Co-Secant	Secant	M.

60 Degrees.

30 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M
0	9.69897	9.93753	9.76144	10.23856	10.06247	10.30103	60
5	70006	93717	76290	23710	06283	29994	55
10	70115	93680	76435	23565	06320	29885	50
15	70224	93643	76580	23420	06357	29776	45
20	70332	93606	76725	23275	06394	29668	40
25	70439	93569	76870	23130	06431	29561	35
30	70547	93532	77015	22985	06468	29453	30
35	9.70654	9.93495	9.77159	10.22841	10.06505	10.29346	25
40	70761	93457	77303	22697	06543	29239	20
45	70867	93420	77447	22553	06580	29133	15
50	70973	93382	77591	22409	06618	29027	10
55	71079	93344	77734	22266	06656	28921	5
60	71184	93307	77877	22123	06693	28816	0
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M

59 Degrees.

31 Degrees.

M	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M
0	9.71184	9.93307	9.77877	10.22123	10.06693	10.28816	60
5	71289	93269	78020	21980	06731	28711	55
10	71393	93230	78163	21837	06770	28607	50
15	71498	93192	78306	21694	06808	28502	45
20	71602	93154	78448	21552	06846	28398	40
25	71705	93115	78590	21410	06885	28295	35
30	71809	93077	78732	21268	06923	28191	30
35	9.71911	9.93038	9.78874	10.21126	10.06962	10.28089	25
40	72014	92999	79015	20985	07001	27986	20
45	72116	92960	79156	20844	07040	27884	15
50	72218	92921	79297	20703	07079	27782	10
55	72320	92881	79438	20562	07119	27680	5
60	72421	92842	79579	20421	07158	27579	0
M	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M

58 Degrees.

32 Degrees.

M.	Sine	Co-Sine	Tangent	C.Tang	Secant	Co-Secant	M
0	9.72421	9.92842	9.79579	10 20421	10.07158	10.27579	60
5	72522	92803	79719	20281	07197	27478	55
10	72622	92763	79860	20140	07237	27378	50
15	72723	92723	80000	20000	07277	27277	45
20	72823	92683	80140	19860	07317	27177	40
25	72922	92643	80279	19721	07357	27078	35
30	73022	92603	80419	19581	07397	26978	30
35	9.73121	9.92563	9.80558	10.19442	10.07437	10.26879	25
40	73219	92522	80697	19303	07478	26781	20
45	73318	92482	80836	19164	07518	26682	15
50	73416	92441	80975	19025	07559	26584	10
55	73513	92400	81113	18887	07600	26487	5
60	73611	92359	81252	18748	07641	26389	0
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M

57 Degrees.

33 Degrees.

M.	Sine	Co.Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
0	9.73611	9.92359	9.81252	10.18748	10.07641	10.26389	60
5	73708	92318	81390	18610	07682	26292	55
10	73805	92277	81528	18472	07723	26195	50
15	73901	92235	81666	18334	07765	26099	45
20	73997	92194	81803	18197	07806	26003	40
25	74093	92152	81941	18059	07848	25907	35
30	74189	92111	82078	17922	07889	25811	30
35	9.74284	9.92069	9.82215	10.17785	10.07931	10.25716	25
40	74379	92027	82352	17648	07973	25621	20
45	74474	91985	82489	17511	08015	25526	15
50	74568	91942	82626	17374	08058	25432	10
55	74662	91900	82762	17238	08100	25338	5
60	74756	91857	82899	17101	08143	25244	0
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M

56 Degrees.

34 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M
0	9.74756	9.91857	9.82899	10.17101	10.08143	10.25244	60
5	74850	91815	83035	16965	08185	25150	55
10	74943	91772	83171	16829	08228	25057	50
15	75036	91729	83307	16693	08271	24964	45
20	75128	91686	83442	16558	08314	24872	40
25	75221	91643	83578	16422	08357	24779	35
30	75313	91599	83713	16287	08401	24687	30
35	9.75405	9.91556	9.83849	10.16151	10.08444	10.24595	25
40	75496	91512	83984	16016	08488	24504	20
45	75587	91468	84119	15881	08532	24413	15
50	75678	91425	84254	15746	08575	24322	10
55	75769	91381	84388	15612	08619	24231	5
60	75859	91336	84523	15477	08664	24141	0
M.	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M

55 Degrees.

35 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M
0	9.75859	9.91336	9.84523	10.15477	10.08664	10.24141	60
5	75949	91292	84657	15343	08708	24051	55
10	76039	91248	84791	15209	08752	23961	50
15	76129	91203	84925	15075	08797	23871	45
20	76218	91158	85059	14941	08842	23782	40
25	76307	91114	85193	14807	08886	23693	35
30	76395	91069	85327	14673	08931	23605	30
35	9.76484	9.91023	9.85460	10.14540	10.08977	10.23516	25
40	76572	90978	85594	14406	09022	23428	20
45	76660	90933	85727	14273	09067	23340	15
50	76747	90887	85860	14140	09113	23253	10
55	76835	90842	85993	14007	09158	23165	5
60	76922	90796	86126	13874	09204	23078	0
M	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M

54 Degrees.

36 Degrees.

M	Sine	Co-Sine	Tangent	C. Tang	Secant	Co-Secant	M.
0	9.76922	9.90796	9.86126	10.13874	10.09204	10.23078	60
5	77009	90750	86259	13741	09250	22991	55
10	77095	90704	86392	13608	09296	22905	50
15	77181	90657	86524	13476	09343	22819	45
20	77268	90611	86656	13344	09389	22732	40
25	77353	90565	86789	13211	09435	22647	35
30	77439	90518	86921	13079	09482	22561	30
35	9.77524	9.90471	9.87053	10.12947	10.09529	10.22476	25
40	77609	90424	87185	12815	09576	22391	20
45	77694	90377	87317	12683	09623	22306	15
50	77778	90330	87448	12552	09670	22222	10
55	77862	90282	87580	12420	09718	22138	5
60	77946	90235	87711	12289	09765	22054	0
M	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

53 Degrees.

37 Degrees.

M	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
0	9.77946	9.90235	9.87711	10.12289	10.09765	10.22054	60
5	78030	90189	87843	12157	09813	21970	55
10	78113	90139	87974	12026	09861	21887	50
15	78197	90091	88105	11895	09909	21803	45
20	78280	90043	88236	11764	09957	21720	40
25	78362	89995	88367	11633	10005	21638	35
30	78445	89947	88498	11502	10053	21555	30
35	9,78527	9,89898	9.88629	10.11371	10.10102	10,21473	25
40	78609	89849	88759	11241	10151	21391	20
45	78691	89801	88890	11110	10199	21309	15
50	78772	89752	89020	10980	10248	21228	10
55	78853	89702	89151	10849	10298	21147	5
60	78934	89653	89281	10719	10347	21066	0
M	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

52 Degrees.

38 Degrees.

M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
0	9.78934	9.89653	9.89281	10.10719	10.10347	10.21066	60
5	79015	89604	89411	10589	10396	20985	55
10	79095	89554	89541	10459	10446	20905	50
15	79176	89504	89671	10329	10496	20824	45
20	79256	89455	89801	10199	10545	20744	40
25	79335	89405	89931	10069	10595	20665	35
30	79415	89354	90060	09940	10646	20585	30
35	9.79494	9.89304	9.90190	10.09810	10.10696	10.20506	25
40	79573	89254	90320	09680	10746	20427	20
45	79652	89203	90449	09551	10797	20348	15
50	79731	89152	90578	09422	10848	20269	10
55	79809	89101	90708	09292	10899	20191	5
60	79887	89050	90837	09163	10950	20113	0
M.	Co-Sine	Sine	C.Tang	Tangent	Co-Secant	Secant	M

51 Degrees.

39 Degrees.

Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M.
9.79887	9.89050	9.90837	10.09163	10.10950	10.20113	60
79965	88999	90966	09034	11001	20035	55
80043	88948	91095	08905	11052	19957	50
80120	88896	91224	08776	11104	19880	45
80197	88844	91353	08647	11156	19803	40
80274	88793	91482	08518	11207	19726	35
80351	88741	91610	08390	11259	19649	30
9.80428	9.88688	9.91739	10.08261	10.11312	10.19572	25
80504	88636	91868	08132	11364	19496	20
80580	88584	91996	08004	11416	19420	15
80656	88531	92125	07875	11469	19344	10
80731	88478	92253	07747	11522	19269	5
80807	88425	92381	07619	11575	19193	0
Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

50 Degrees.

40 Degrees.

Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M
9.80807	9.88425	9.92381	10.07619	10.11575	10.19193	60
80882	88372	92510	07490	11628	19118	55
80957	88319	92638	07362	11681	19043	50
81032	88266	92766	07234	11734	18968	45
81106	88212	92894	07106	11788	18894	40
81180	88158	93022	06978	11842	18820	35
81254	88105	93150	06850	11895	18746	30
9.81328	9.88050	9.93278	10.06722	10.11950	10.18672	25
81402	87996	93406	06594	12004	18598	20
81475	87942	93533	06467	12058	18525	15
81549	87887	93661	06339	12113	18451	10
81622	87833	93789	06211	12167	18378	5
81694	87778	93916	06084	12222	18306	0
Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M

49 Degrees.

41 Degrees.

Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant	M
9.81694	9.87778	9.93916	10.06084	10.12222	10.18306	60
81767	87723	94044	05956	12277	18233	55
81839	87668	94171	05829	12332	18161	50
81911	87613	94299	05701	12387	18089	45
81983	87557	94426	05574	12443	18017	40
82055	87501	94554	05446	12499	17945	35
82126	87446	94681	05319	12554	17874	30
9.82198	9.87390	9.94808	10.05192	10.12610	10.17802	25
82269	87334	94935	05065	12666	17731	20
82340	87277	95062	04938	12723	17660	15
82410	87221	95190	04810	12779	17590	10
82481	87164	95317	04683	12836	17519	5
82551	87107	95444	04556	12893	17449	0
Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant	M.

48 Degrees.

42 Degrees.

M	Sine	Co-Sine	Tangent	C.Tang.	Secant	Co-Secant
0	9.82551	9.87107	9.95444	10.04556	10.12893	10.17449
5	82621	87050	95571	04429	12950	17379
10	82691	86993	95698	04302	13007	17309
15	82761	86936	95825	04175	13064	17239
20	82830	86879	95952	04048	13121	17170
25	82899	86821	96078	03922	13179	17101
30	82968	86763	96205	03795	13237	17032
35	9.83037	9.86705	9.96332	10.03668	10.13295	10.16963
40	83106	86647	96459	03541	13353	16894
45	83174	86589	96586	03414	13411	16826
50	83242	86530	96712	03288	13470	16758
55	83310	86472	96839	03161	13528	16690
60	83378	86413	96966	03034	13587	16622
M	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant

47 Degrees.

43 Degrees

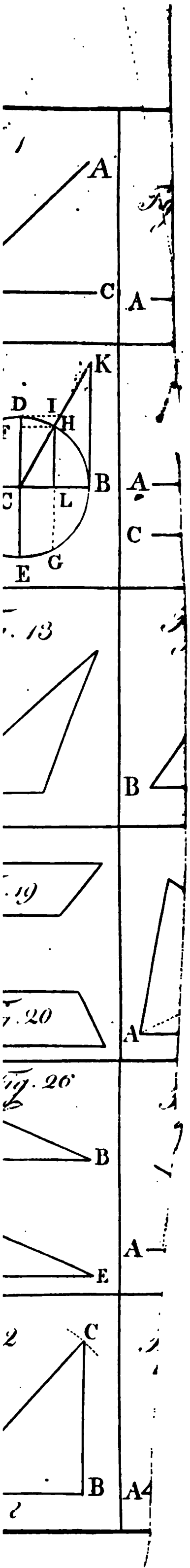
M.	Sine	Co-Sine	Tangent	C. Tang.	Secant	Co-Secant
0	9.83378	9.86413	9.96966	10.03034	10.13587	10.16622
5	83446	86354	97092	02908	13646	16554
10	83513	86295	97219	02781	13705	16487
15	83581	86235	97345	02655	13765	16419
20	83648	86176	97472	02528	13824	16352
25	83715	86116	97598	02402	13884	16285
30	83781	86056	97725	02275	13944	16219
35	9.83848	9.85996	9.97851	10.02149	10.14004	10.16152
40	83914	85936	97978	02022	14064	16086
45	83980	85876	98104	01896	14124	16020
50	84046	85815	98231	01769	14185	15954
55	84112	85754	98357	01643	14246	15888
60	84177	85693	98484	01516	14307	15823
M	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant

46 Degrees.

44 Degrees.

M.	Sine	Co-Sine	Tangent	C.Tang.	Secant	Co-Secant
0	9.84177	9.85693	9.98484	10.01516	10.14307	10.15823
5	84242	85632	98610	01390	14368	15758
10	84308	85571	98737	01263	14429	15692
15	84373	85510	98863	01137	14490	15627
20	84437	85448	98989	01011	14552	15563
25	84502	85386	99116	00884	14614	15498
30	84566	85324	99242	00758	14676	15434
35	9.84630	9.85262	9.99368	10.00632	10.14738	10.15370
40	84694	85200	99495	00505	14800	15306
45	84758	85137	99621	00379	14863	15242
50	84822	85074	99747	00253	14926	15178
55	84885	85012	99874	00126	14988	15115
60	84949	84949	10.00000	10.00000	15051	15051
M	Co-Sine	Sine	C. Tang.	Tangent	Co-Secant	Secant

45 Degrees.



A
C
A
K
D
I
F
H
B
A
C
L
C
E
G
13
B
19
20
A
Fig. 26
B
A
E
2
C
B
A

Fig. 58.

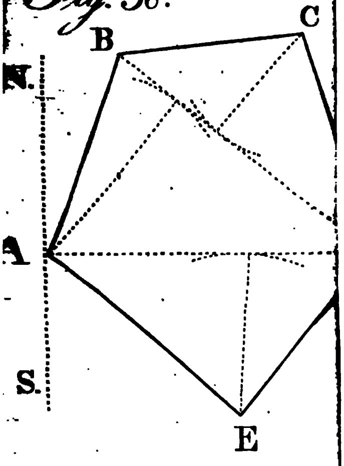
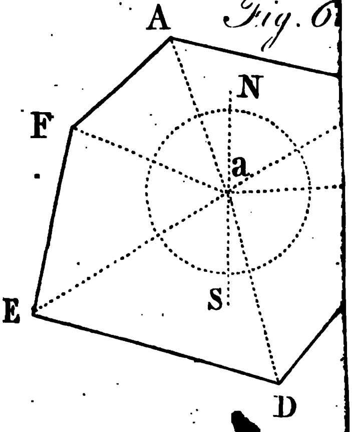
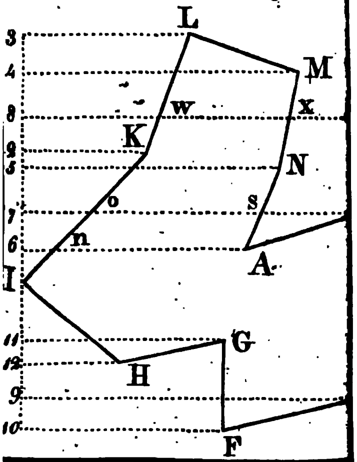
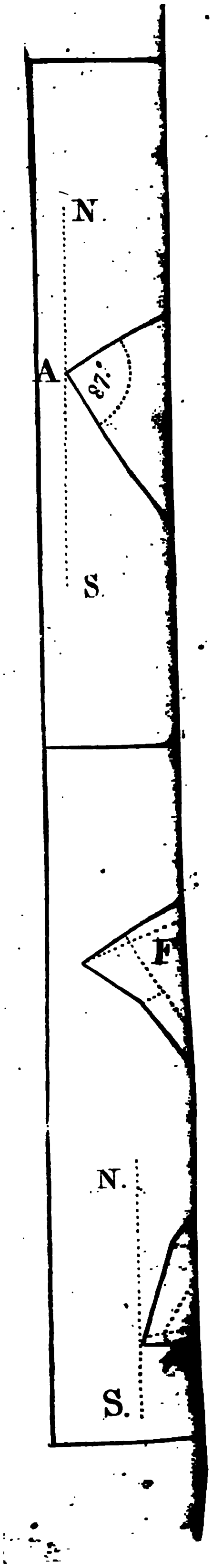


Fig. 6






N.
A
87°
S.
F
N.
S.